Efficiency and skipper skill in the Danish fishing fleet

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Preface

This report is a result of the project ‘An Economic Management Model for the Fishery in Denmark (EMMFID)’ funded by the Danish Ministry of Food, Agriculture and Fisheries. The project that closed at the end of 2004 was organized in several modules. One of the modules comprised investigations into the efficiency of fishing vessels by use of Data Envelopment Analysis (DEA). There are several reasons for differences in efficiency between vessels. Some arise from differences in vessel characteristics (technology), some from factors outside the control of the fishermen (exogenous factors), and some from different skills of the fishermen. This report contains DEA results used (i) to investigate the influence of chosen exogenous factors on the efficiency of the entire Danish fishing fleet in 2002, and (ii) to estimate efficiencies dependent on the skippers’ skill for three trawler segments of the Danish fleet in 2002. The results of (i) have been used to build a second stage module, which can estimate Catch Per Unit Effort (CPUE) matrices depending on the value of the exogenous factors. The results of (ii) show that for the three trawler segments, exogenous factors outside the control of the skipper are the major reasons for the differences of efficiencies between the vessels.

These results speak for themselves. However, the work was also carried out with the purpose to develop a methodology that could fit into the Food and Resource Economics Institute’s model for the structure and the capacity of the fishing fleet. In this model, the EMMFID model, catch per unit effort plays an important role for the economic performance of the vessel and the required effort to catch the quotas. If the catch per unit effort is within the control of the skipper or the manager, for example by his use of technology, prospects for an increase in catch per unit effort will entail larger imbalance between the fleet capacity and the size of the fish stocks. The results shown in this report do not constitute the end of this work, as further development as how to combine these results with the EMMFID model’s catch per unit effort is required.

The work has been carried out by research fellow Ayoe Hoff, Ph.D., assisted by senior economic adviser Hans Frost, and secretary Elsebeth Vidø has been responsible for the final editing of the report.

Food and Resource Economics Institute, August 2005.

Jørgen Løkkegaard

1. Introduction

The project 'An Economic Management Model for the Fishery in Denmark (EMMFID)'[1] funded by the Danish Ministry of Food, Agriculture and Fisheries, has the overall objective 'to be able to describe (model) scenarios in a way that allows the management system to address the results' and 'make better use of available economic and biological information in an integrated way'. In this connection the primary aim of the project has been to construct a bio-economic model covering the whole Danish fishery. The chosen model uses a 'what-if' and 'what's-best' approach to analyse management questions in the Danish fishery, see Deacon et al. (1998) and Wilen (2000) for an exposition of the achievements of the conventional bioeconomic theory. The EMMFID model is documented in Frost and Kjærsgaard (2003) and applied in Frost and Kjærsgaard (2005).

The project includes several independent sub-modules, each investigating certain aspects of the Danish fishery. For one of these modules B3, the objective of is to 'Study productivity in the Danish fleet using DEA or Index Analyses'. This objective is further clarified by 'If there is great uncertainty about the efficiency of the existing fleet, it will be impossible to say anything about what will happen in the future if the regulation is changed, and with that, whether the intended objectives of the management are reached. The project gives important information about technical progress, which is of great importance for the validity of the results from the dynamical model (i.e. the EMMFID model). Valuation of the economic efficiency and productivity of the fleet is valuable information for the management, when designing the regulation. Is economic progress caused by e.g. technical improvements, improved stocks, favourable price changes, better choices of inputs/outputs or…?'.

It has in the present context been chosen to focus on analysing the current efficiency of the Danish fishing fleet, with special focus on (i) the influence of exogenous non-discretionary factors on efficiency, and (ii) identification of pure skipper skill efficiency, both valuable tools seen from a management perspective. Firstly exogenous factors outside the influence of the vessel owner (skipper), such as management-induced factors, will affect the fishing ability of the vessel, i.e. it's absolute efficiency. Given that it is often a sub-objective of management schemes to optimize the efficiency of the fishing fleet, it is important for the decision makers to know how a proposed management scheme will affect efficiency at the individual vessel as well as

[1] In Danish: 'En Økonomisk Management Model for Fiskeriet i Danmark (EMMFID)'

the average fleet level. The assessment of pure skipper skill efficiency is also important for decision makers, as this is a measure of the amount of efficiency that cannot be changed by management.

The analyses have been performed for the Danish fishing fleet in 2002. Second stage Data Envelopment Analysis (Coelli et al. 1999) has been used to investigate the relationship between exogenous factors and efficiency for the total fleet, while four-stage DEA (Fried et al. 1999) has been used to investigate skipper skill efficiency for three major trawl segments in the fleet.

Exogenous factors are described by Coelli et al. (1999) as 'factors, which could influence the efficiency of a firm, where such factors are non traditional inputs and are assumed not under the control of the manager' (or skipper). As they are non traditional inputs it does not seem appropriate to include them as ordinary inputs or outputs in the DEA models, as the DEA inputs and outputs are physical measures under direct control of the skipper. Coelli et al. (1999) and Fried et al. (1999) give reviews of the different methods used to approach this problem, running from the 'frontier-separation approach', through the 'all-in-one approach' to the 'second stage approach'. The latter consists of two steps, (i) evaluation of individual vessel efficiencies with DEA but not including the exogenous factors and (ii) regression, using the tobit technique, of the efficiencies against the exogenous variables. Coelli et al. (1999) conclude the review by recommending the second stage approach as the most appropriate given that (Coelli et al. 1999):

- 'It can accommodate more than one variable'
- 'It can accommodate both continuous and categorical variables'
- 'It does not make prior assumptions regarding the direction of the influence of the categorical variable'
- 'It is easy to calculate'
- 'The method is simple and therefore transparent'

It is added that this method makes it possible to assess the influence of exogenous factors on efficiency.

The estimated second stage DEA models for the fleet have been used to create a module for scaling of the Catch Per Unit Effort (CPUE) matrices used in the EMMFID model as a function of exogenous variables of relevance to the management. The scaling module can as such be used to predict the future structure of the fishing fleet as a function of regulation initiatives. It can be argued that it would be a more direct method to regress the CPUE values directly against the exogenous factors, but this would be a tremendous task, as it involves regressing each of the 118 species included in the EMMFID model separately against the exogenous variables for each of the 26 fleet segments present in the fleet in 2002 in each of the 12 months considered. Thus some kind of approximation must be used, and in the present context it has been chosen to scale CPUE radially according to efficiency, rather than e.g. to aggregate the 118 species into groups and regress these against the exogenous factors.

Finally the second stage method is often mentioned in connection with assessment of pure management efficiency, which in the present case will be called ‘skipper skill’ efficiency. Ray (1991) uses scaled residuals of the tobit regression to assess the management efficiency of Connecticut school districts. McCarty and Yaisawarng (1993) use non-scaled residuals as a non-bounded index for management efficiency. Fried et al (1999) extend the two-stage method by (i) including non-radial slacks in the evaluation of the efficiencies, and (ii) adding two more steps that enable the evaluation of pure non-biased measures of management efficiency (in the present context skipper skill). It is the last method that is used in the present context to assess skipper skill for three Danish Trawl segments in 2002.

The report includes an outline of the different methods used, including DEA, a short discussion of influential observations in DEA, tobit regression, the CPUE scaling module and the four-stage method. Following this is a presentation of the data for the Danish fleet in 2002 used in the analysis, succeeded by a presentation of the results of the two- and four-stage analyse, and an example of the use of the CPUE scaling module.

2. Data Envelopment Analysis (DEA)

To date DEA has been used in numerous applications in the fishery see e.g. Pascoe and Mardle (2003), and Vestergaard et al. (2000). For a detailed introduction to DEA refer to Cooper et al. (2000) and Coelli et al. (1999).

In the present application the aim is to assess how far the observed Catch Per Unit Effort (CPUE) of individual vessels is from technically optimal CPUE, and how this degree of utilisation is affected by exogenous factors of relevance to management. Therefore an output orientated DEA approach is appropriate, the outline of which is:

$$
\begin{aligned}
&\max_{\lambda} \theta_i \\
&s.t. \\
&\theta_i \cdot y_{i.k} \le \sum_{j=1}^{N} \lambda_j \cdot y_{j,k}\,; \quad k = 1,\dots,K \\
&x_{i,l} \ge \sum_{j=1}^{N} \lambda_j \cdot x_{j.l}\,; \quad l = 1,\dots,L \\
&1 = \sum_{j=1}^{N} \lambda_j \\
&\lambda_j \ge 0 \qquad \forall j
\end{aligned}
\tag{1}
$$

where $y_{i,k}$ is the k'th output (K outputs in all) of the i'th observations (N observations in all), $x_{i,l}$ is the l'th input (L inputs in all) of the i'th observation, λ_j is the variational DEA weights, and θ_i is the output orientated technical efficiency score for the i'th observation. Thus $\theta_i \geq 1$ is the amount by which the output of the i'th observation must be increased to reach full utilisation. If θ_i=1 the observation is fully efficient. The unit sum of the DEA weights ensures Variable Returns to Scale (VRS).

The above DEA program has been performed for the total Danish fleet in 2002, which has been divided into 26 segments depending on vessel length and gear[2]. Data for each segment has been aggregated at the monthly level, and 12 DEA programs has thus been run for each segment. For some of the fleet segments it has, however, not been possible to perform DEA, as these segments contain too few observations per

[2] Determined by the registration used in the vessel register at the Danish Fisheries Directorate, cf. Frost and Kjærsgaard (2003).

month, when evaluated by the so-called ‘rule of thumb’ (Cooper et al., 2000), which states that the number of observations must be $\geq \max\{K \times L, 3(K+L)\}$, where L is the number of inputs and K the number of outputs. It has in all been possible to perform DEA and subsequent second stage tobit regressions for 17 of the 26 segments.

As inputs in each DEA run have been used total vessel length, maximum horsepower of the vessels and number of crewmembers on the vessels. Days at Sea (DAS) are not included, as the output CPUE is catch per DAS. As DAS is not included, and as this is the most important variable input in the short run, the problem (1) evaluates technical efficiency, where no inputs are allowed to vary freely, as opposed to capacity efficiency, where variable inputs are allowed to vary freely.

CPUE of a number of aggregated species groups has been used as output. The species groups vary from one vessel segment to another and will be discussed below in the data-section.

3. Influential observations

Each separate DEA run results in individual DEA scores for each vessel in the given month and segment. As the EMMFID model however operates with average CPUE values for each month and segment[3], average DEA scores have also been estimated for each month and segment. In connection with this, influential observations, i.e. single observations that to an extreme degree influence the monthly averages and the regression results, have been removed before calculation of the DEA score averages and running of the tobit regressions. The influential observations are divided into two categories, (i) influential observations on the frontier, and (ii) extremely inefficient observations.

The former category, influential observations on the frontier, includes fully efficient observations that influence the location of the frontier to an extreme degree. If they are removed from the sample the average efficiency will change considerably because the frontier location is altered significantly. Figure 1 shows an example of this, where the influential observation, highlighted by an open circle, pulls the frontier outwards. Influential observations on the frontier are identified using super efficiency DEA, which measures the frontier observations relative to each other to determine which are 'most efficient'. For details on evaluation of super efficiency, refer to e.g. Wilson (1995).

The second category, extremely inefficient observations, includes observations that are extremely far from the frontier when compared to the overall trend for the total sample. Figure 2 shows and example of this, where the extremely inefficient observation is highlighted by an open circle.

[3] And moreover for each species, fishing area and home county. The three latter have been aggregated in the DEA evaluations

Figure 1. **Example of an influential observation (highlighted by an open circle) on the frontier.**

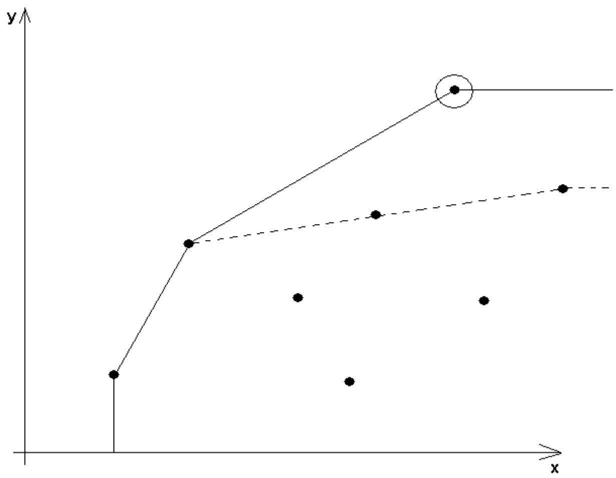
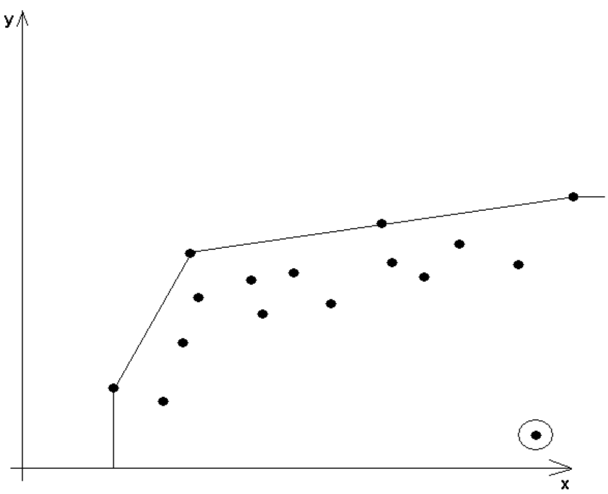


Figure 2. **Example of extremely inefficient observation (highlighted by an open circle).**



Both types of influential observations have been removed from the data-sample in the present context before calculating average efficiencies and performing tobit regressions. The reason for removing the influential observations is that the aim is to obtain representative values for the average efficiencies, and not average efficiencies that are strongly influenced by a few extreme observations.

Contrary to this, influential observations have not been removed before evaluating skipper skill efficiencies. The reason is that these are used as guidelines for absolute value of skipper skill efficiencies, where the aim is to investigate the difference between ‘raw’ efficiencies including all forms of noise, and ‘pure’ skipper skill efficiencies where all forms of exogenous noise is removed.

4. Second Stage Tobit Regression

In order to assess how exogenous factors affect vessel efficiency, the output orientated DEA efficiency scores have been regressed against a number of chosen exogenous variables. As the efficiency scores are limited from below at unity, tobit regression has been used. This method is designed to perform regression in the case where the dependent variable is limited from below or above or both (Maddala, 1986). For a discussion of the usefulness of tobit regression in second stage DEA, refer to Hoff (2004).

The basic assumption of tobit regression is that a 'true' (latent) variable $y^* \in [-\infty;\infty]$ is underlying the observed dependent variable $y \in [a;\infty]$, where $a=1$ in the present application. It is further assumed that a linear relationship prevails between y^* and the exogenous variables $(X_1,\ldots,X_M)$:

$$y^* = \sum_{m=1}^{M} \beta_m \cdot X_m + u \tag{2}$$

where $u \sim N(0,\sigma)$ are independent and identically normally distributed residuals. Given this, the observed variable y is given by:

$$y = \begin{cases} \sum_{m=1}^{M} \beta_m \cdot X_m + u & ; \quad a < \sum_{m=1}^{M} \beta_m \cdot X_m + u \\ a & ; \quad a > \sum_{m=1}^{M} \beta_m \cdot X_m + u \end{cases} \tag{3}$$

This relationship, and the fact that $u \sim N(0,\sigma)$, is used to estimate the regression parameters β, i.e. the effects of the exogenous variables, applying log-likelihood. For further details, refer to Maddala (1986) and Wooldridge (2002).

Given equation (3), the expected value of y as a function of the exogenous variables is not equal to equation (2), as this is the expectation of the latent variable y^*. The expectation of the observed variable y is on the contrary given by (Maddala, 1986):

$$E(y|x) = \Phi\left(\frac{1-X'\beta}{\sigma}\right) + X'\beta\left[1-\Phi(\frac{1-X'\beta}{\sigma})\right] + \sigma \cdot \phi(\frac{1-X'\beta}{\sigma}) \tag{4}$$

where $\Phi(z)$ and $\phi(x)$ are the distribution and density functions for the standard normal distribution, and $X'\beta = \Sigma \beta_m \cdot X_m$

In the present application the chosen exogenous variables are: (i) Vessel age, (ii) Vessel owner status, (iii) Fraction of time spent fishing in the Kattegat (3AS), the Skagerrak (3AN) and the Baltic (3BCD) of total time spent fishing, (iv) Gross tonnage, and (v) Insurance value (measured in ’00,000 DKK). These variables will be outlined in detail below.

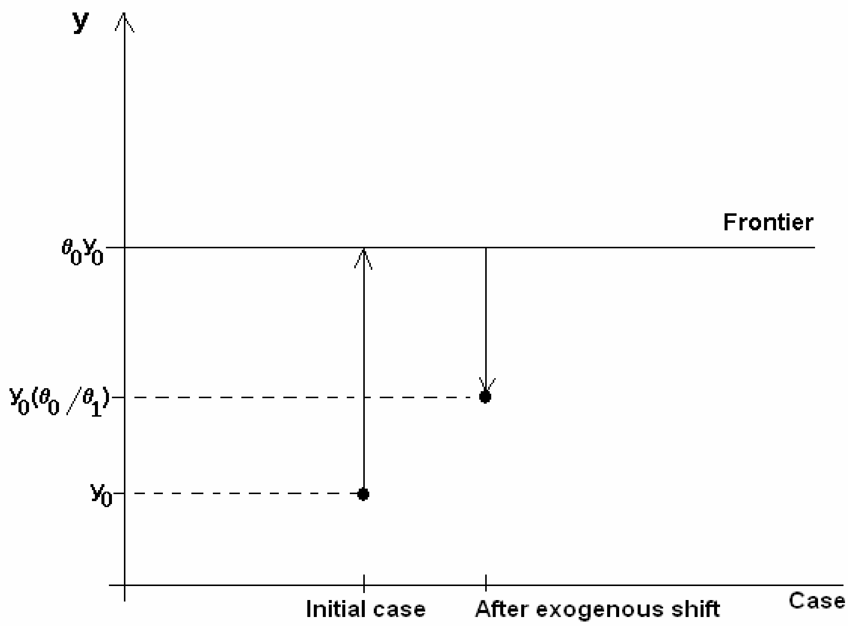
5. Evaluating CPUE as a function of the exogenous variables

With the estimated tobit models described above it is possible to (i) estimate individual vessel efficiencies given individual values of the exogenous variables and (ii) estimate the average efficiency for a given vessel segments and months of 2002[4], using a vector of average values of the exogenous variables for the chosen segment and month. The latter approach is used in the present context, as the evaluated efficiencies are used to estimate new levels of the average CPUE matrices used in the EMMFID model.

When the level of the average exogenous variables for a vessel segment changes, this will affect the fishing possibilities for the segment, and it is thus expected that the average CPUE for the segment will also change. If it is assumed that the efficient frontier is not moving, it is straightforward to evaluate the new average CPUE levels using the old and new average efficiencies for the segment, cf. figure 3. In this figure y_0 is the original observed average CPUE vector used in the EMMFID model[5] for a given segment and month and $\theta_0>1$ is the (arithmetic) average of the original DEA efficiency scores for the segment and month[6]. A positive change is then introduced in one or more of the exogenous variables (relative to the observed average values) and the efficiency score thus changes to $1<\theta_1<\theta_0$, where θ_1 is calculated with equation (4), thus moving the absolute level of CPUE closer to the frontier (if a negative change is introduced $\theta_1>\theta_0$, and the new level of CPUE will be further away from the frontier than the original level). As it is assumed that the frontier is not moving during the shift, the fully efficient CPUE level is the same before and after the exogenous shift, i.e. $\theta_0 \cdot y_0 = \theta_1 \cdot y_1$, where y_1 is the new CPUE level. Thus $y_1 = y_0(\theta_0/\theta_1)$.

[4] If it has been possible to perform DEA for that segment and month, cf. the discussion about the rule of thumb above.
[5] The vector is disaggregated into 118 individual species groups, and further disaggregated by fishing area, homeport and month.
[6] In Appendix A is presented a discussion of why the arithmetic average (and not a weighted value) is used to evaluate average efficiencies.

Figure 3. **Change in original CPUE average vector (y_0) during a shift in exogenous variables when the frontier location stays constant during the shift.**

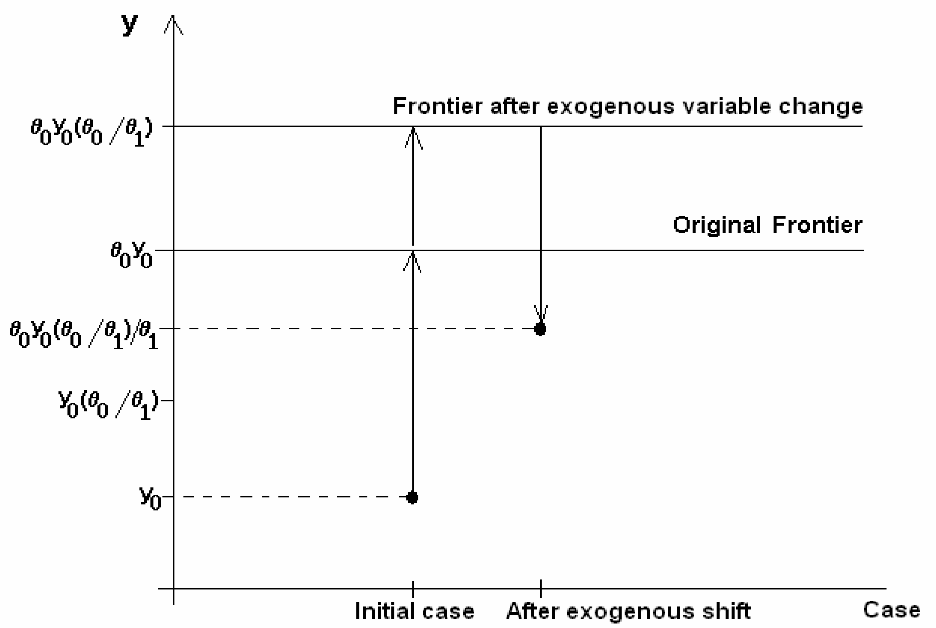


The frontier may however also move when the exogenous variables change, as the observations on the frontier might also be affected by the shift. Thus if the change due to the exogenous shift is positive (increases CPUE) the above method will underestimate the new levels of CPUE, as the frontier will move outwards. Likewise the above method will overestimate the new CPUE levels if the exogenous change is negative, as the frontier will in this case move inwards. The movement of the frontier can be approximated using the fact that the alterations of the CPUE matrices are based on average and not individual vessel values. Using this and the discussion performed in connection with figure 3 above, it is suggested that the total sample at most moves (θ_0/θ_1) given an exogenous change. The frontier will at most move (θ_0/θ_1), and the frontier projection of y_0, i.e. $y_1 = y_0\theta_0$, will thus move to $y_2 = (y_0\theta_0)(\theta_0/\theta_1)^n$, where 0<$n$<1 determines how much the frontier moves (see figure 4). This is equal to the projection of the new CPUE level onto the new frontier, i.e. $y_2 = (y_0\theta_0)(\theta_0/\theta_1)^n = \theta_1 \cdot y_1$. Thus the new CPUE level is given by:

$$y_1 = (y_0\theta_0)(\theta_0/\theta_1)^n / \theta_1 = y_0(\theta_0/\theta_1)^{1+n} \quad (5)$$

with $0<n<1$. $n=0$ when the frontier does not move at all, and $n=1$ when the frontier moves as much as the average sample movement.

Figure 4. **Change in original CPUE value (y0) during an exogenous shift when the frontier location is also changed due to the exogenous change.**

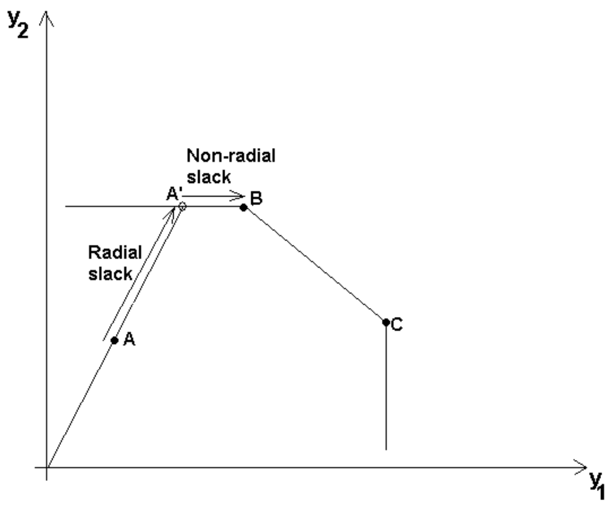


6. The four-stage method

The four-stage method, proposed by Fried et al. (1999), for evaluation of skipper skill efficiency is not a direct extension of the second stage method, the difference being that the four-stage method includes evaluation of non-radial slacks in the first stage. The method comprises the following four steps:

1. Evaluation of total output slacks (radial plus non-radial) for each output and observation. This includes evaluation of radial technical output-orientated DEA efficiency θ_i (cf. equation 1) for each observation i together with possible frontier slacks $s_{k,i}$ for each output k and observation i. The frontier slack is the output excess that occurs when the observation is projected onto a part of the frontier that runs parallel with one of the axes see e.g. Coelli *et.al.* (1999). This is illustrated in figure 5 that shows firms A, B and C producing the outputs y_1 and y_2, each using the same amount of input. The observation A projects onto the observation A' on the frontier, which is not an efficient point as A' could increase the amount of output y_1 to the point B without using more input. The horizontal distance between A' and B is the output slack for output y_1 for firm A. The total output slack for output k of observation i is then given by $S_{k,i}=(\theta_i-1)y_{k,i}+s_{k,i}$.

Figure 5. Illustration of total output slack.



2. Regression of the output slacks against the relevant exogenous variables. I.e. k regressions must be performed, one for each output:

$$S_{k,i} \equiv f_k(X_{1,i},..., X_{M,i}) + u_{k,i} \tag{6}$$

If different exogenous variables are believed to influence the different outputs, different explanatory variables can be included in each of the k equations. The functions regressed against the slacks need not be linear, but it must in each equation be included in the fitting technique that the output slacks are positive, i.e. have a lower limit of zero. Thus regression techniques for limited/censored dependant variables must be employed, e.g. tobit regression.

3. The relationships (6) identified in the previous step are used to estimate expected output slacks for each observation, given the observed exogenous variables. When tobit regression with a lower limit censoring at zero is used, the expected slack is given by Maddala (1986):

$$\hat{S}_{k,i} = \left[\sum_{j=1}^{M} X_{i,j}\beta_j\right] \cdot \Phi\left(\frac{\sum_{j=1}^{M} X_{i,j}\beta_j}{\sigma}\right) + \sigma \cdot \phi\left(\frac{\sum_{j=1}^{M} X_{i,j}\beta_j}{\sigma}\right) \tag{7}$$

with the same notation as in equation (4). Thus the observed slack for each observation is replaced by the slack that could be expected for an average vessel with the observed exogenous conditions. If the observed slack is equal to the expected slack, the vessel performs as well as an average vessel with the given exogenous conditions. If the observed slack is less than the expected slack, the vessel performs better than the average vessel, which could be due to good skipper skill. Conversely, if the observed slack is higher than the expected slack, the vessel performs worse than an average vessel, which could be due to poor skipper skills.

4. The set of expected average slacks for each observation is used to create a new set of corrected outputs by:

$$\hat{y}_{k,i} = y_{k,i} + \hat{S}_{k.i} - E_k \tag{8}$$

E_k adjusts the whole set of outputs to some predefined exogenous base. This may be the base of least favourable exogenous conditions, in which case E_k=Max$_j$[$\hat{S}_{k,j}$] is used, i.e. the maximum expected slack for output k among all observations. Or it may be the base of most favourable or average exogenous conditions, in which cases E_k=Min$_j$[$\hat{S}_{k,j}$] or E_k=Mean$_j$[$\hat{S}_{k,j}$] are used. Fried et al. (1999) generally recommend the base of least favourable exogenous conditions as this is attainable for all vessels. In the output-orientated case this base may however create negative corrected output values. Therefore the base of most favourable exogenous conditions has been used in the present work.

The corrected output samples (equation 8) are finally employed in a new DEA calculation of radial technical inefficiency. As these new measures of inefficiency are corrected for external factors and evaluated at an equal exogenous base, they measure ‘non-explicable’ inefficiency including skipper skill.

7. Data

The present analysis employs data for the Danish fishing fleet in 2002. The reason for not using newer data is that these were not available when the work was initiated. The methods can of course be repeated for more recent data if so desired.

The DEA and second stage evaluations have been performed for 17 out of the 26 fleet segments employed in Frost and Kjærsgaard (2003). The analyses have been performed on a monthly level for each segment. Table 1 below shows the number of observations, i.e. active vessels, available in each month of 2002 for each of the 26 segments.

Inputs to the DEA models are for all segments vessel length, maximum horsepower, and number of crew members. Table 2 shows the average values and standard deviations in 2002 for the 17 vessel segments, for which it has been possible to perform DEA evaluations.

As outputs in the DEA programs are used CPUE (kg/days at sea) aggregated into species groups covering all fishing areas and home counties. These groups vary from one segment to another, depending on the species targeted for the different segments. Table 3 shows the output groups used for the 17 vessel segments.

Table 1. **Number of observations (active vessels) in the Danish fleet in each month of 2002.**

Vessel Length		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Okt	Nov	Dec
<12 m	LG	107	104	113	115	107	103	94	07	96	98	97	100
	TS	14	14	16	15	13	13	13	8	11	11	13	8
	DSNT	37	36	35	36	29	32	32	28	32	32	31	34
	TR	22	20	22	24	22	24	24	27	23	24	25	27
12-15 m	LG	77	72	77	79	77	77	75	76	74	73	76	76
	DSNT	31	30	34	33	34	32	31	33	32	31	34	33
	DS	18	18	19	19	18	18	18	18	19	20	20	19
	TR	146	146	145	138	144	138	135	137	138	138	140	140
15-18 m	LG	39	40	40	40	40	38	39	36	37	37	39	37
	DSNT	10	10	10	7	9	10	8	10	10	0	10	9
	DS	20	18	23	23	23	23	23	24	24	23	20	17
	TR	109	109	111	107	103	98	96	105	108	111	112	107
18-24 m	LG	25	27	27	27	27	27	26	26	25	26	26	25
	DSNT	8	8	7	8	8	8	8	8	8	8	8	8
	DS	30	29	38	41	40	40	39	38	38	37	34	31
	TR	100	100	102	100	104	104	98	106	106	103	100	97
24-40 m	BT	7	7	7	6	6	7	7	7	7	7	8	8
	DSNT	5	5	5	5	5	5	5	5	5	5	5	5
	TRO	74	75	77	76	77	81	78	81	80	81	79	73
	TRI	42	33	42	47	49	47	40	46	49	49	46	33
>40 m	PS	10	10	6	2	11	11	10		11	11	11	1
	TRO	18	17	18	19	19	19	11	17	17	19	12	9
	TRI	12	9	13	14	14	14	13	13	14	14	13	12
Special fisheries	NP	22	20	23	23	23	23	23	23	23	22	23	22
	MU	27	18	59	60	60	54	5	7	59	64	63	61
	CS	1		1	1	1	1	1	1	1	1		1

Note: 'LG'=Liners and Gill netters, 'TS'=Trap Setters etc., 'DSNT'=Danish Seiners/Netters/Trawlers, 'TR'=Trawlers, 'DS'=Danish Seiners, 'BT'=Beam Trawlers, 'TRO'=Trawlers, other, 'TRI'=Trawlers, industrial, 'PS'=Purse Seiners, 'NP'=Northern Prawn, 'MU'=Mussels, 'CS'=Common Shrimp

Table 2.	Averages and Standard Deviations of the inputs used in the DEA programs. All are totals over all months in 2002.

Vessel Length		Vessel Length Aver-age	St. Dev.	Maximum Horsepower Aver-age	St. Dev.	No. Crew members Aver-age	St. Dev.	Vessel Length Aver-age	St. Dev.	Maximum Horsepower Average	St. Dev.	No. Crew members Aver age	St. Dev.
<12 m	LG	10.22	1.07	109.06	41.41	1.32	0.55	10.22	1.07	109.06	41.41	1.32	0.55
	TS	-	-	-	-	-	-	-	-	-	-	-	-
	DSNT	10.56	0.95	128.62	42.04	1.21	0.43	10.56	0.95	128.62	42.04	1.21	0.43
	TR	11.34	0.57	150.86	31.75	1.34	0.47	11.34	0.57	150.86	31.75	1.34	0.47
12-15 m	LG	13.19	0.96	165.08	54.48	2.25	0.99	13.19	0.96	165.08	54.48	2.25	0.99
	DSNT	12.89	0.77	178.23	49.95	1.72	0.79	12.89	0.77	178.23	49.95	1.72	0.79
	DS	13.15	1.11	165.5	37.63	2.20	0.52	13.15	1.11	165.5	37.63	2.20	0.52
	TR	13.68	0.93	224.21	64.45	1.81	0.58	13.68	0.93	224.21	64.45	1.81	0.58
15-18 m	LG	16.35	0.81	233.49	72.70	3.61	0.99	16.35	0.81	233.49	72.70	3.61	0.99
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	DS	16.74	0.76	207.19	57.96	2.73	0.69	16.74	0.76	207.19	57.96	2.73	0.69
	TR	16.09	0.87	293.86	94.70	2.34	0.68	16.09	0.87	293.86	94.70	2.34	0.68
18-24 m	LG	19.77	1.54	339.70	83.57	4.32	0.82	19.77	1.54	339.70	83.57	4.32	0.82
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	DS	19.38	0.98	270.96	84.36	3.16	0.57	19.38	0.98	270.96	84.36	3.16	0.57
	TR	20.32	1.60	456.81	153.47	3.12	0.77	20.32	1.60	456.81	153.47	3.12	0.77
24-40 m	BT	-	-	-	-	-	-	-	-	-	-	-	-
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	TRO	31.33	3.93	796.66	192.83	4.21	0.88	31.33	3.93	796.66	192.83	4.21	0.88
	TRI	35.72	3.22	829.35	203.25	4.62	0.86	35.72	3.22	829.35	203.25	4.62	0.86
>40 m	PS	-	-	-	-	-	-	-	-	-	-	-	-
	TRO	-	-	-	-	-	-	-	-	-	-	-	-
	TRI	-	-	-	-	-	-	-	-	-	-	-	-
Special fisheries	NP	17.44	1.66	256.19	43.60	2.78	0.59	17.44	1.66	256.19	43.60	2.78	0.59
	MU	13.50	3.62	167.43	71.41	1.72	0.50	13.50	3.62	167.43	71.41	1.72	0.50
	CS	-	-	-	-	-	-	-	-	-	-	-	-

Note 1: 'LG'=Liners and Gill netters, 'TS'=Trap Setters etc., 'DSNT'=Danish Seiners/Netters/Trawlers, TR'=Trawlers, 'DS'=Danish Seiners, 'BT'=Beam Trawlers, 'TRO'=Trawlers, other, 'TRI'=Trawlers, industrial, PS'=Purse Seiners, 'NP'=Northern Prawn, 'MU'=Mussels, 'CS'=Common Shrimp
Note 2: No standard deviations are reported for the Common Shrimp segment, as this only contains one vessel.

Table 3. Output CPUE groups (kg/days at sea), aggregated over all fishing areas, used in the DEA programs for the Danish fleet in 2002.

Vessel Length		Output Groups (CPUE, given in kg/days at sea)
<12 m	LG	Cod, Other Codfish, Plaice, Other Flatfish, Other Species
	TS	-
	DSNT	Cod, Other Codfish, Plaice, Other Flatfish, Other Species
	TR	Codfish, Flatfish, Other Species
12-15 m	LG	Cod, Other Codfish, Plaice, Other Flatfish, Other Species
	DSNT	Cod, Other Codfish, Plaice, Other Flatfish, Other Species
	DS	Codfish, Flatfish, Other Species
	TR	Cod, Other Codfish, Plaice, Other Flatfish, Lobster, Herring, Industry Species, Other Species
15-18 m	LG	Cod, Other Codfish, Plaice, Other Flatfish, Other Species
	DSNT	-
	DS	Codfish, Flatfish, Other Species
	TR	Cod, Other Codfish, Plaice, Other Flatfish, Lobster, Industry Species, Other Species
18-24 m	LG	Cod, Other Codfish, Plaice, Other Flatfish, Other Species
	DSNT	-
	DS	Cod, Other Codfish, Plaice, Other Flatfish, Other Species
	TR	Cod, Other Codfish, Plaice, Other Flatfish, Lobster, Industry Species, Other Species
24-40 m	BT	-
	DSNT	-
	TRO	Codfish, Flatfish, Herring, Industry Species, Other Species
	TRI	Industry Species, Other Species
>40 m	PS	-
	TRO	-
	TRI	-
Special fisheries	NP	Northern Prawn, Other Species
	MU	Mussels, Oysters, Other Species
	CS	-

Note 1: ‘LG’=Liners and Gill netters, ‘TS’=Trap Setters etc., ‘DSNT’=Danish Seiners/Netters/Trawlers, ’TR’=Trawlers, ‘DS’=Danish Seiners, ’BT’=Beam Trawlers, ’TRO’=Trawlers, other, ’TRI’=Trawlers, industrial, ’PS’=Purse Seiners, ’NP’=Northern Prawn, ’MU’=Mussels, ’CS’=Common Shrimp
Note 2: ‘-‘ means that no DEA analyses have been performed for the segment due to too few observations.

The exogenous variables used in the second stage tobit regression models are:

- Vessel age (relative to the year 2002).
- Vessel owner status represented by a dummy variable that is equal to 1 for ‘single owner status’ (fully occupied) and equal to 0 for ‘other status’ (other occupation, company owned etc.).

- Fraction of time spent fishing in the Kattegat (3AS), the Skagerrak (3AN) and the Baltic (3BCD), of total time spent fishing. These three must each be less than 1, and their sum must also be less than or equal to 1. If the sum is strictly less than 1, this means that some time has been used in the North Sea (4ABC) and other areas.
- Gross tonnage.
- Insurance value (measured in 100.000 DKK).

Table 4 shows averages of these over the total year for the 17 segments for which it has been possible to perform DEA analyses. For the average of the owner status it must be noticed that this is the average of a dummy. When this average is close to unity it means that the majority of the dummy variables are equal to *1*, and thus that most of the observed vessels in the considered segment have single owners with full occupation as fishermen.

Table 4.	Averages of the seven exogenous variables used in the tobit regressions to model the DEA efficiency scores for the Danish fleet in 2002. All are totals over all months in 2002.

Vessel Length		Vessel Age	Owner Status	Fraction 3AN	Fraction 3AS	Fraction 3BCD	Gross Tonnage	Insurance (100.000 DKK)
<12 m	LG	26.54	0.87	0.18	0.14	0.46	8.60	7.89
	TS	-	-	-	-	-	-	-
	DSNT	28.19	0.87	0.11	0.21	0.58	11.36	0.34
	TR	45.10	0.93	0.22	0.27	0.42	14.42	8.43
12-15 m	LG	35.23	0.90	0.28	0.09	0.24	18.51	14.77
	DSNT	33.58	0.82	0.14	0.15	0.55	17.20	12.16
	DS	38.43	0.73	0.52	0.28	0.17	18.42	10.73
	TR	39.95	0.89	0.24	0.29	0.39	21.95	15.10
15-18 m	LG	27.79	0.67	0.07	0.03	0.08	33.34	25.46
	DSNT	-	-	-	-	-	-	-
	DS	43.16	0.92	0.32	0.07	0.24	41.17	18.94
	TR	32.36	0.86	0.32	0.28	0.31	31.08	24.96
18-24 m	LG	26.46	0.77	0.03	0.03	0.01	72.47	39.81
	DSNT	-	-	-	-	-	-	-
	DS	35.38	0.69	0.24	0.04	0.24	55.10	32.57
	TR	29.87	0.78	0.33	0.13	0.18	76.16	46.19
24-40 m	BT	-	-	-	-	-	-	-
	DSNT	-	-	-	-	-	-	-
	TRO	30.43	0.51	0.29	0.03	0.05	219.06	102.03
	TRI	27.52	0.36	0.02	0	0.08	295.36	132.25
>40 m	PS	-	-	-	-	-	-	-
	TRO	-	-	-	-	-	-	-
	TRI	-	-	-	-	-	-	-
Special fisheries	NP	21.44	0.69	0.00	0	0.01	42.23	38.80
	MU	34.27	0.59	0	0.04	0.10	18.10	18.00
	CS	-	-	-	-	-	-	-

Note 1: ‘LG’=Liners and Gill netters, ‘TS’=Trap Setters etc., ‘DSNT’=Danish Seiners/Netters/Trawlers, ‘TR’=Trawlers, ‘DS’=Danish Seiners, ’BT’=Beam Trawlers, ’TRO’=Trawlers, other, ’TRI’=Trawlers, industrial, ’PS’=Purse Seiners, ’NP’=Northern Prawn, ’MU’=Mussels, ’CS’=Common Shrimp

8. Results of the DEA evaluations

The DEA model (1) has been performed for 17 out of the 26 segments. For each segment a separate DEA has been run for each month in 2002. As mentioned above influential observations have been removed for each segment, before (i) evaluating average efficiencies for each segment in each month of 2002, and (ii) performing second stage tobit regressions. Table 5 shows the resulting (arithmetic) average efficiencies. Figure 6-9 illustrates the efficiencies for Liners and Gill Netters, Danish Seiners, Trawlers below 24 m and Trawlers above 24 m.

Table 5. Average DEA output orientated technical efficiencies for the Danish fleet in 2002.

Vessel Length		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Okt	Nov	Dec
<12 m	LG	3.10	3.78	5.16	3.13	2.23	2.74	2.84	2.76	2.87	2.26	2.49	2.87
	TS	-	-	-	-	-	-	-	-	-	-	-	-
	DSNT	1.62	1.66	2.01	1.70	1.12	1.28	1.30	1.32	1.42	1.64	1.33	1.16
	TR	1.44	1.60	1.43	1.38	1.58	3.94	1.45	3.38	1.71	1.63	1.73	1.82
12-15 m	LG	1.72	2.06	1.79	1.49	1.72	1.53	1.99	1.71	1.82	1.47	1.78	1.66
	DSNT	1.09	1.06	1.47	1.08	1.33	1.24	1.27	1.38	1.24	1.17	1.14	1.04
	DS	1.23	1.81	1.44	1.15	1.19	1.16	1.40	1.10	1.37	1.67	1.29	1.46
	TR	1.54	1.64	1.57	1.41	1.50	1.40	1.44	1.37	1.42	1.46	1.44	1.43
15-18 m	LG	1.28	1.45	1.34	1.22	1.05	1.19	1.32	1.27	1.36	1.34	1.23	1.78
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	DS	1.45	1.57	1.91	1.30	1.55	1.63	1.68	1.51	1.30	1.64	1.56	1.85
	TR	1.55	1.60	1.61	1.25	1.46	1.39	1.36	1.43	1.33	1.70	1.40	1.80
18-24 m	LG	1.13	1.15	1.13	1.06	1.07	1.01	1.09	1.10	1.37	1.23	1.37	1.25
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	DS	1.22	1.45	1.68	1.20	1.15	1.12	1.24	1.11	1.22	1.23	1.33	1.57
	TR	1.57	2.43	1.54	1.41	1.41	1.37	1.29	1.43	1.38	1.48	1.40	1.56
24-40 m	BT	-	-	-	-	-	-	-	-	-	-	-	-
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	TRO	2.01	1.93	1.53	1.46	1.55	1.57	1.83	2.33	2.97	2.76	2.13	2.09
	TRI	2.60	1.65	1.51	1.24	1.20	1.32	1.70	1.52	1.36	1.35	1.52	2.15
>40 m	PS	-	-	-	-	-	-	-	-	-	-	-	-
	TRO	-	-	-	-	-	-	-	-	-	-	-	-
	TRI	-	-	-	-	-	-	-	-	-	-	-	-
Special fisheries	NP	1.28	1.30	1.23	1.20	1.35	1.41	1.30	1.37	1.33	1.28	1.49	1.47
	MU	1.65	1.57	2.12	1.95	2.26	1.46	3.17	3.17	2.66	2.68	2.71	2.96
	CS	-	-	-	-	-	-	-	-	-	-	-	-

Note: 'LG'=Liners and Gill netters, 'TS'=Trap Setters etc., 'DSNT'=Danish Seiners/Netters/Trawlers, 'TR'=Trawlers, 'DS'=Danish Seiners, 'BT'=Beam Trawlers, 'TRO'=Trawlers, other, 'TRI'=Trawlers, industrial, 'PS'=Purse Seiners, 'NP'=Northern Prawn, 'MU'=Mussels, 'CS'=Common Shrimp

Figure 6 indicates that Liners and Gill Netters below 12 m are somewhat more inefficient[7] than the bigger vessels. It is further seen that the Liners and Gill Netters are generally becoming more efficient, i.e. have efficiencies approaching unity, with increasing vessel length. This reason is believed to be that the number of Liners and Gill Netters decreases with increasing vessel length (cf. table 1). Generally more observations will have efficiency equal to unity when the number of observations in a sample decreases. There are no general seasonal trends in the efficiencies for the Liners and Gill Netters, except that it seems that the vessels below 12 m are especially inefficient in the beginning of 2002.

Figure 7 shows that the average efficiencies for the Danish Seiners are more or less of the same order of magnitude for the three segments that have been investigated. There are no general seasonal trends for these segments.

For the trawlers below 24 m figure 8 shows that the efficiencies are more or less of the same order of magnitude for the 4 segments, except that there are some rather extreme fluctuations for the segment below 12 m. This is believed to be caused by a higher uncertainty for this segment given few observations (cf. table 1). Finally, for the two trawl segments above 24 m figure 9 shows that there particularly seems to be some seasonal variation for the Trawl/Other segment that appears to be most efficient, i.e. have efficiency scores closest to unity, from March to June. Likewise some seasonal variation also seems to be present for the Trawl/Industry segment that appears to have two efficient periods, around May and around September/October.

[7] As the DEA efficiencies are output orientated, a vessel is more inefficient the greater it's efficiency is than unity, as the efficiency score measures how much the vessels output must be increased in order to reach full utilisation.

Figure 6. Average DEA output orientated efficiencies for Liners and Gill Netters in 2002.

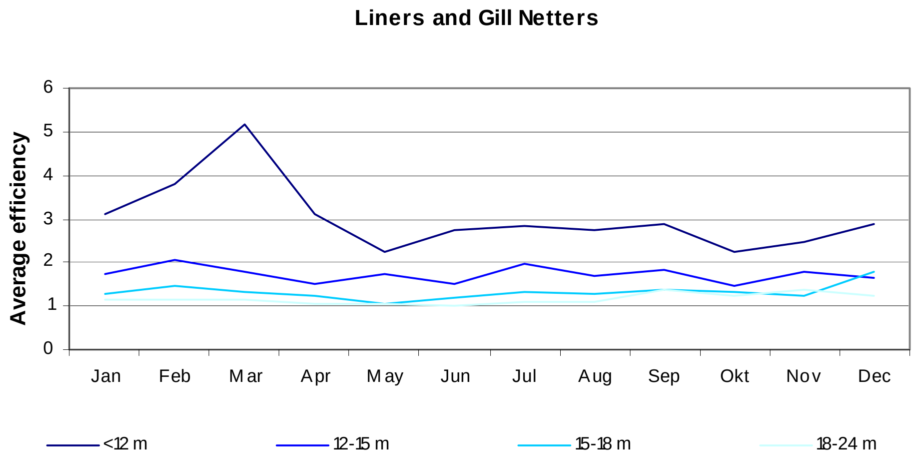


Figure 7. Average DEA output orientated efficiencies for Danish Seiners in 2002.

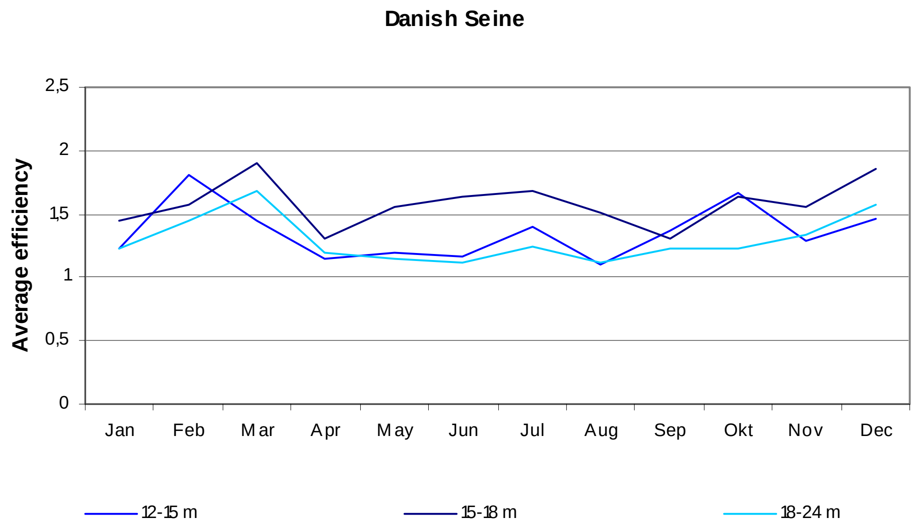


Figure 8. Average DEA output orientated efficiencies for Trawlers below 24 m in 2002.

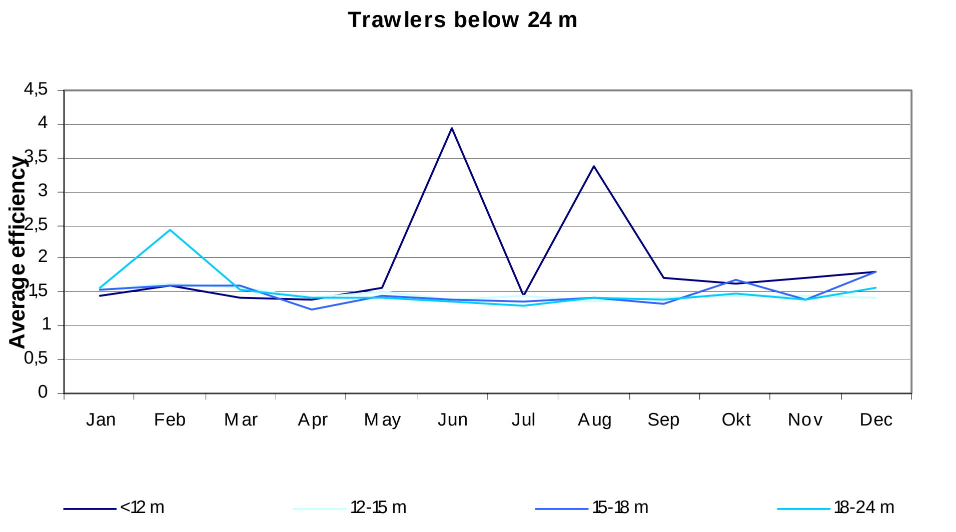
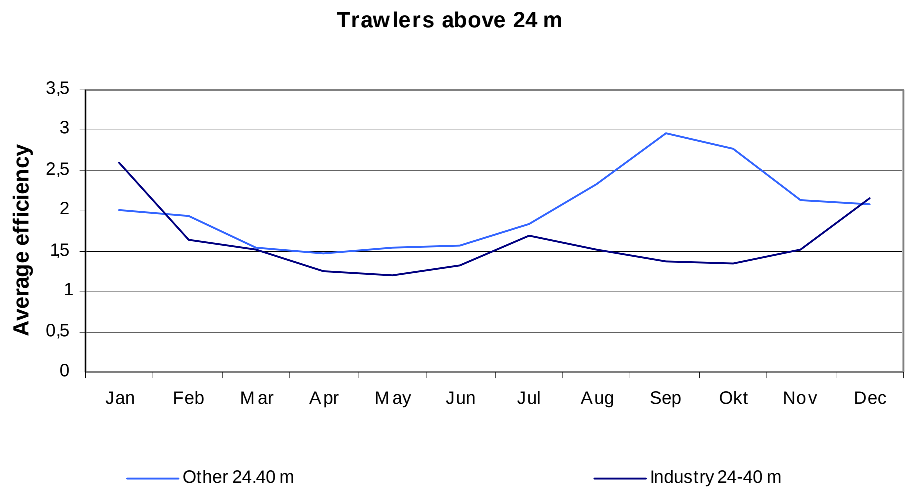


Figure 9. Average DEA output orientated efficiencies for Trawlers above 24 m in 2002.



9. Results of the second stage analyses

Second stage tobit regression analyses have been performed for each of the 17 segments for which it has been possible to perform DEA. For each segment a separate regression has been performed for each month in 2002. This results in 12 individual sets of regression coefficients, corresponding to the seven exogenous variables described above, for each of the 17 segments. These are presented in table 1B to 17B in appendix B.

Table 6 presents the average efficiencies predicted with the tobit models (using equation 4) given the observed average exogenous variables presented in table 4. If the explanatory power is high, it must be expected that these predicted efficiencies are close to the DEA average efficiencies given in table 5. Table 7 thus presents the relative deviation between the observed and the estimated average efficiencies, i.e. $\theta_{obs} / \theta_{pred}$, where θ_{pred} are the predicted efficiencies given in table 6, and θ_{obs} are the observed efficiencies given in table 5.

Table 7 firstly shows that the explanatory power of the tobit models is generally good for liners and gill-netters, especially for vessels below 15 m. For Danish Seiners/Netters/ trawlers the explanatory power varies from really good (Danish Seiners/Netters/Trawlers <12 m in April and June) to rather poor (Danish Seiners/Netters/Trawlers <12 m in October). For Trawlers <12 m the explanatory power is poor, while it is good for trawlers between 12 and 24 m, and for industry trawlers 24-40 m. For Other Trawlers 24-40 m, the explanatory power is good for most months, but poor in especially November. For Danish Seiners 12-15 m (the only Danish seiner segment for which it has been possible to perform DEA) the explanatory power varies from good to extremely poor (in April). There is no apparent reason for this other than the number of observations is generally low for the Danish Seiners thus creating large uncertainty in the tobit model. Finally for the specialised segments the explanatory power is really good for both the Northern Prawn vessels, and the Mussel vessels, except for the latter in July and August. The reason for this is the very low number of observations in these two months.

Thus generally it can be concluded that the explanatory power of the estimated tobit models is generally rather good, although some noise may bias the results of the model.

Table 6. **Average efficiencies for the Danish fleet in 2002, predicted with the estimated second stage tobit models, using the average exogenous variables (table 4) as inputs.**

Vessel Length		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Okt	Nov	Dec
<12 m	LG	3.37	3.98	5.36	3.36	2.35	2.85	2.97	2.89	3.04	2.39	2.61	2.94
	TS	-	-	-	-	-	-	-	-	-	-	-	-
	DSNT	1.53	1.61	1.88	1.68	1.00	1.27	1.06	1.18	1.03	1.10	1.21	1.04
	TR	1.07	1.13	1.20	1.00	1.26	3.65	1.29	2.46	1.61	1.50	1.42	1.00
12-15 m	LG	1.72	2.17	1.82	1.50	1.66	1.50	2.00	1.70	1.74	1.40	1.75	1.66
	DSNT	1.00	1.00	1.16	1.00	1.13	1.00	1.17	1.11	1.00	1.02	1.07	1.00
	DS	1.19	1.61	1.00	2.38	1.04	1.00	1.16	1.04	1.08	1.18	1.00	1.00
	TR	1.58	1.65	1.06	1.43	1.52	1.40	1.46	1.38	1.43	1.46	1.45	1.43
15-18 m	LG	1.20	1.40	1.34	1.00	1.00	1.15	1.22	1.18	1.40	1.28	1.08	1.70
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	DS	1.26	1.20	1.89	1.28	1.41	1.00	1.62	1.00	1.01	1.24	1.35	1.70
	TR	1.65	1.64	1.63	1.25	1.45	1.41	1.36	1.44	1.32	1.69	1.47	1.91
18-24 m	LG	1.08	1.00	1.00	1.01	1.04	1.00	1.04	1.08	1.32	1.11	1.00	1.24
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	DS	1.09	1.38	1.63	1.18	1.13	1.09	1.24	1.10	1.20	1.19	1.05	1.56
	TR	1.55	2.77	1.54	1.43	1.42	1.39	1.23	1.41	1.38	1.52	1.44	1.67
24-40 m	BT	-	-	-	-	-	-	-	-	-	-	-	-
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	TRO	2.01	1.86	1.5	1.45	1.56	1.59	1.82	2.34	2.91	2.71	2.01	2.09
	TRI	2.57	1.47	1.49	1.22	1.17	1.27	1.65	1.50	1.34	1.32	1.02	2.44
>40 m	PS	-	-	-	-	-	-	-	-	-	-	-	-
	TRO	-	-	-	-	-	-	-	-	-	-	-	-
	TRI	-	-	-	-	-	-	-	-	-	-	-	-
Special fisheries	NP	1.22	1.19	1.16	1.20	1.34	1.38	1.29	1.36	1.30	1.27	1.35	1.42
	MU	1.47	1.50	2.04	1.97	2.28	1.40	1.00	1.00	2.63	2.73	2.76	3.05
	CS	-	-	-	-	-	-	-	-	-	-	-	-

Note: 'LG'=Liners and Gill netters, 'TS'=Trap Setters etc., 'DSNT'=Danish Seiners/Netters/Trawlers, 'TR'=Trawlers, 'DS'=Danish Seiners, 'BT'=Beam Trawlers, 'TRO'=Trawlers, other, 'TRI'=Trawlers, industrial, 'PS'=Purse Seiners, 'NP'=Northern Prawn, 'MU'=Mussels, 'CS'=Common Shrimp

Table 7. Relative deviations between observed efficiencies for the Danish fleet in 2002, and expected efficiencies evaluated with the tobit models.

Vessel Length		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Okt	Nov	Dec
<12 m	LG	0.92	0.95	0.96	0.93	0.95	0.96	0.96	0.96	0.94	0.95	0.95	0.97
	TS	-	-	-	-	-	-	-	-	-	-	-	-
	DSNT	1.06	1.03	1.07	1.01	1.12	1.01	1.23	1.12	1.38	1.48	1.10	1.11
	TR	1.35	1.42	1.20	1.38	1.26	1.08	1.12	1.38	1.06	1.09	1.22	1.82
12-15 m	LG	1.00	0.95	0.98	0.99	1.03	1.02	0.99	1.01	1.04	1.05	1.01	1.00
	DSNT	1.09	1.06	1.26	1.08	1.17	1.24	1.09	1.24	1.24	1.15	1.06	1.04
	DS	1.04	1.13	1.44	0.48	1.14	1.16	1.20	1.06	1.26	1.41	1.29	1.46
	TR	0.98	1.00	0.98	0.99	0.98	1.00	0.99	0.99	0.99	1.00	0.99	1.00
15-18 m	LG	1.07	1.04	1.00	1.22	1.05	1.03	1.08	1.07	0.97	1.04	1.14	1.05
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	DS	1.15	1.31	1.01	1.01	1.10	1.62	1.04	1.51	1.29	1.33	1.16	1.09
	TR	0.94	0.98	0.98	1.00	1.01	0.99	1.00	0.99	1.01	1.00	0.96	0.94
18-24 m	LG	1.05	1.15	1.13	1.05	1.03	1.01	1.05	1.02	1.04	1.11	1.37	1.01
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	DS	1.12	1.05	1.03	1.02	1.02	1.02	1.00	1.01	1.02	1.03	1.27	1.01
	TR	1.01	0.88	1.00	0.99	1.00	0.99	1.05	1.02	1.00	0.98	0.98	0.94
24-40 m	BT	-	-	-	-	-	-	-	-	-	-	-	-
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	TRO	1.01	1.12	1.01	1.02	1.03	1.04	1,03	1.01	1.02	1.03	1.49	0.88
	TRI	1.00	1.04	1.02	1.00	0.99	0.99	1.01	1.00	1.02	1.02	1.06	1.00
>40 m	PS	-	-	-	-	-	-	-	-	-	-	-	-
	TRO	-	-	-	-	-	-	-	-	-	-	-	-
	TRI	-	-	-	-	-	-	-	-	-	-	-	-
Special fisheries	NP	1.05	1.09	1.06	1.00	1.01	1.02	1.01	1.01	1.02	1.01	1.10	1.04
	MU	1.12	1.04	1.04	0.99	0.99	1.04	3.17	3.17	1.01	0.98	0.98	0.97
	CS	-	-	-	-	-	-	-	-	-	-	-	-

Note: 'LG'=Liners and Gill netters, 'TS'=Trap Setters etc., 'DSNT'=Danish Seiners/Netters/Trawlers, 'TR'=Trawlers, 'DS'=Danish Seiners, 'BT'=Beam Trawlers, 'TRO'=Trawlers, other, 'TRI'=Trawlers, industrial, 'PS'=Purse Seiners, 'NP'=Northern Prawn, 'MU'=Mussels, 'CS'=Common Shrimp

10. Generating CPUE using the second stage DEA results

Based on the second stage DEA models a module for generating CPUE changes, given changes in the exogenous variables, has been created in *Mathematica*. This section presents an example, based on fleet renewal, on how the module works.

It is assumed that a renewal of the 2002 fleet takes place, thus resulting in the average vessel age being halved relative to the original average values (cf. table 4). Thus the first step is to create a matrix of average exogenous variables, containing the original average exogenous variables (cf. table 4) except for the age, which have been divided by 2. Table 8 shows a fraction (containing entries for Liners and Gill Netters below 12 m from January to July 2002) of the new exogenous variable matrix that will extend through 17 vessel segments containing 12 months each, i.e. have $17 \cdot 12 = 204$ entries in all.

Table 8. The first seven entries of an exogenous variable matrix for the 2002 fleet, where all average ages have been halved.

MONTH	age	Owner status	Das3an	das3as	das3bcd	gtgrt	Insurance	Segment
1	24.76/2	0.92	0.17	0.06	0.61	8.25	8.09	Gku12m
2	26.46/2	0.89	0.14	0.07	0.64	8.61	7.89	Gku12m
3	26.90/2	0.88	0.18	0.08	0.51	8.49	7.65	Gku12m
4	26.95/2	0.84	0.25	0.07	0.39	8.44	7.68	Gku12m
5	27.89/2	0.83	0.25	0.13	0.32	8.45	7.57	Gku12m
6	26.54/2	0.82	0.21	0.14	0.35	8.65	7.68	Gku12m
7	26.85/2	0.85	0.22	0.18	0.36	8.83	7.68	Gku12m

Note:'das3an'=fraction time spend in 3AN, 'das3as'=fraction time spend in 3AS, 'das3BCD'=fraction time spend in 3BCD, 'gtgrt'=Gross Tonnage.

This exogenous variable matrix is then used to evaluate a matrix of expected efficiencies, given the new age structure, using the second stage tobit models presented above. Table 9 shows the resulting average efficiencies, while table 10 shows the relative deviations between the observed average efficiencies (table 5), and the new expected efficiencies, i.e. $\theta_{obs} / \theta_{pred}$. It is seen that $\theta_{obs} / \theta_{pred} > 1$ for most segments in most months, i.e. that the average efficiencie generally decrease when the average age is halved. This is expected, as a decrease means that the efficiency approaches unity, i.e. full efficiency, and as it should be expected that the fleet becomes more efficient when renewed.

Table 9. Average efficiencies for the Danish fleet in 2002, predicted with the estimated second stage tobit models using observed average exogenous variables (table 4), but with the average age half of the observed value.

Vessel Length		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Okt	Nov	Dec
<12 m	LG	3.31	3.72	5.08	3.19	2.14	2.66	2.53	2.58	3.08	2.39	3.02	3.00
	TS	-	-	-	-	-	-	-	-	-	-	-	-
	DSNT	1.32	1.25	2.00	1.38	1.00	1.12	1.03	1.04	1.01	1.16	1.30	1.02
	TR	1.26	1.43	1.06	1.00	1.35	1.90	1.22	3.07	1.64	1.79	1.61	1.00
12-15 m	LG	1.70	2.32	1.73	1.56	1.64	1.59	1.85	1.91	1.93	1.28	1.70	1.70
	DSNT	1.00	1.00	1.01	1.00	1.03	1.00	1.34	1.02	1.00	1.02	1.08	1.00
	DS	2.36	1.23	1.00	1.04	1.06	1.00	1.01	1.00	1.04	1.00	1.00	1.00
	TR	1.66	1.58	1.71	1.43	1.76	1.55	1.60	1.38	1.49	1.53	1.49	1.38
15-18 m	LG	1.03	1.23	1.28	1.00	1.00	1.12	1.20	1.29	1.34	1.23	1.03	1.30
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	DS	1.10	2.70	2.29	1.26	1.18	1.03	2.48	1.00	1.01	1.27	1.25	1.25
	TR	1.43	1.63	1.59	1.24	1.38	1.25	1.26	1.37	1.36	1.63	1.37	1.48
18-24 m	LG	1.13	1.00	1.00	1.00	1.05	1.02	1.16	1.06	1.05	1.57	1.01	1.52
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	DS	1.11	1.99	2.35	1.42	1.13	1.03	1.10	1.21	1.24	1.19	1.00	2.16
	TR	1.54	2.59	1.72	1.58	1.52	1.45	1.35	1.49	1.40	1.85	1.48	2.03
24-40 m	BT	-	-	-	-	-	-	-	-	-	-	-	-
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	TRO	2.10	1.42	1.23	1.21	1.14	1.32	1.20	1.19	1.31	1.47	1.05	2.69
	TRI	1.76	1.92	1.54	1.43	1.53	1.58	1.87	2.36	2.67	2.49	2.36	1.80
>40 m	PS	-	-	-	-	-	-	-	-	-	-	-	-
	TRO	-	-	-	-	-	-	-	-	-	-	-	-
	TRI	-	-	-	-	-	-	-	-	-	-	-	-
Special fisheries	NP	1.10	1.16	1.07	1.19	1.30	1.25	1.19	1.36	1.22	1.15	1.29	1.17
	MU	1.29	1.34	2.02	1.85	2.21	1.36	20.26	20.26	2.68	2.54	2.30	3.00
	CS	-	-	-	-	-	-	-	-	-	-	-	-

Note: 'LG'=Liners and Gill netters, 'TS'=Trap Setters etc., 'DSNT'=Danish Seiners/Netters/Trawlers, 'TR'=Trawlers, 'DS'=Danish Seiners, 'BT'=Beam Trawlers, 'TRO'=Trawlers, other, 'TRI'=Trawlers, industrial, 'PS'=Purse Seiners, 'NP'=Northern Prawn, 'MU'=Mussels, 'CS'=Common Shrimp

Table 10. Relative deviations between observed efficiencies (table 5) and expected efficiencies (table 9), given that the average age has been halved, for the Danish fleet in 2002.

Vessel Length		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Okt	Nov	Dec
<12 m	LG	0.88	1.03	1,03	0.96	1.08	1.06	1.26	1.14	0.87	0.90	0.68	0.91
	TS	-	-	-	-	-	-	-	-	-	-	-	-
	DSNT	1.52	1.75	1.01	1.53	1.25	1.30	1.58	1.62	1.97	2.01	1.04	1.29
	TR	1.31	1.25	1.82	1.90	1.37	4.32	1.41	1.21	1.09	0.83	1.15	3.31
12-15 m	LG	1.02	0.79	1.07	0.91	1.10	0.93	1.15	0.80	0.89	1.32	1.09	0.95
	DSNT	1.19	1.12	2.11	1.17	1.65	1.54	0.89	1.82	1.54	1.33	1.11	1.08
	DS	0.27	2.17	2.07	1.22	1.27	1.35	1.93	1.20	1.73	2.77	1.66	2.13
	TR	0.86	1.07	0.85	0.98	0.72	0.82	0.81	0.98	0.91	0.92	0.93	1.07
15-18 m	LG	1.55	1.38	1.10	1.49	1.10	1.13	1.20	0.97	1.02	1.19	1.44	1.88
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	DS	1.73	0.34	0.70	1.07	1.72	2.52	0.46	2.28	1.67	1.66	1.55	2.18
	TR	1.18	0.97	1.03	1.02	1.13	1.24	1.17	1.09	0.96	1.09	1.04	1.48
18-24 m	LG	0.99	1.32	1.28	1.12	1.04	0.98	0.88	1.09	1.72	0.61	1.83	0.67
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	DS	1.21	0.53	0.51	0.71	1.04	1.18	1.27	0.85	0.97	1.06	1.76	0.53
	TR	1.04	0.88	0.80	0.79	0.86	0.89	0.91	0.92	0.98	0.64	0.89	0.59
24-40 m	BT	-	-	-	-	-	-	-	-	-	-	-	-
	DSNT	-	-	-	-	-	-	-	-	-	-	-	-
	TRO	1.54	1.36	1.52	1.05	1-12	1.00	1.99	1.63	1.08	0.85	2.08	0.64
	TRI	1.30	1.01	0.99	1.04	1.03	0.98	0.96	0.98	1.24	1.22	0.82	1.35
>40 m	PS	-	-	-	-	-	-	-	-	-	-	-	-
	TRO	-	-	-	-	-	-	-	-	-	-	-	-
	TRI	-	-	-	-	-	-	-	-	-	-	-	-
Special fisheries	NP	1.35	1.26	1.31	1.01	1.08	1.27	1.19	1.02	1.19	1.24	1.33	1.58
	MU	1.63	1.37	1.10	1.11	1.05	1.15	0.02	0.02	0.98	1.11	1.39	0.97
	CS	-	-	-	-	-	-	-	-	-	-	-	-

Note: 'LG'=Liners and Gill netters, 'TS'=Trap Setters etc., 'DSNT'=Danish Seiners/Netters/Trawlers, 'TR'=Trawlers, 'DS'=Danish Seiners, 'BT'=Beam Trawlers, 'TRO'=Trawlers, other, 'TRI'=Trawlers, industrial, 'PS'=Purse Seiners, 'NP'=Northern Prawn, 'MU'=Mussels, 'CS'=Common Shrimp

The final step in the CPUE generation module uses the new efficiency matrix given in table 9 to change the original CPUE matrix, based on average CPUE values for each vessel segment in each month of 2002[8], using equation (5). In this connection the question arises about which value to use for the frontier movement n ($1 \le n \le 2$). The

[8] The CPUE matrix is further split down at the species and area level, but all CPUE values belonging to a given segment and month are corrected by the same factor $(\theta_0 / \theta_1)^{1+n}$ (cf. equation 5), where θ_0 and θ_1 are the efficiencies for that segment and month before and after alteration of the exogenous variables.

correct value can be set by either using an informed guess or estimated e.g. using index theory. In the present example the frontier movement factor is set to *1*, i.e. it is assumed that the frontier will not move during the fleet renewal, which means that it is only non-efficient vessels that are renewed. Table 11 shows an extract of a typical CPUE matrix (the full matrix has 8211 entries), while table 12 shows the same cross section after the renewal of the fleet.

Table 11. Extract of a typical CPUE matrix used in the EMMFID model.

	Month											
Segment[1]	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	244	0	0	0
2	0	0	0	0	0	0	0	0	0	1.28	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0.23
4	0	0	0	0	0	0	0	0	0	0	0	23.8
5	0	0	0	0	0	0	0	0	0	19.2	0	0
6	0	0	0	0	0	0	0	0	0	50.4	0	0
7	0	0	3.89	0	0	0.21	3.83	0.1	89.3	1.27	0.45	0
8	36.5	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0.09	0
10	0	0	0	0	0.38	0	0.53	0	0	0	0	0
11	0	0	0	0	0	0	0.29	0	0.69	0	0	0
12	0	0	0.47	0	0	0	1.53	1.89	0.9	0	0	0
13	0	0	0	0	0	0	41.2	5.36	0	0	0	0

Notes 1:The vessel segments are disaggregated down to species, fishing area, homeport and vessel segment.

Table 12. The CPUE matrix shown in table 9 after changes of the exogenous factors by halving of the age.

	Month											
Segment[1]	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	227	0	0	0
2	0	0	0	0	0	0	0	0	0	1.17	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0.22
4	0	0	0	0	0	0	0	0	0	0	0	23.8
5	0	0	0	0	0	0	0	0	0	18.2	0	0
6	0	0	0	0	0	0	0	0	0	57.8	0	0
7	0	0	3.95	0	0	0.22	4.3	0.11	83.2	1.2	0.37	0
8	39.8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0.09	0
10	0	0	0	0	0.32	0	0.48	0	0	0	0	0
11	0	0	0	0	0	0	0.31	0	0.68	0	0	0
12	0	0	0.47	0	0	0	1.92	2.41	1.26	0	0	0
13	0	0	0	0	0	0	44.2	4.79	0	0	0	0

Notes 1:The vessel segments are disaggregated down to species, fishing area, homeport and vessel segment.

The above example shows how a given CPUE matrix used in the EMMFID model can be changed given a change in exogenous variables. This is a valuable tool in connection with evaluating effects of management-induced changes using the EMMFID model.

11. Skipper skill efficiencies for Danish trawlers in 2002

The four-stage method has been used to assess average skipper skill efficiencies for three fleet segments consisting of trawlers between 12-15 m, trawlers between 15-18 m and trawlers between 18-24 m in 2002. These segments have been chosen, as they constitute the dominating part of the fleet, i.e. have the highest number of active vessels in all months, cf. table 1.

Table 13, 14 and 15 show basic statistics for the 'raw' efficiencies and the pure skipper skill efficiencies for the three segments in each month of 2002. With 'raw' efficiencies is meant technical output orientated efficiencies evaluated with the model (1) without investigating for influential observations or correcting for exogenous variables. Contrary to this the skipper skill efficiencies are stripped of all influence of exogenous factors, and this only reflects the efficiency relating to non-measurable internal factors.

The first thing to notice from the three tables is that the maximum skipper skill efficiencies are generally considerably lower than the corresponding maximum value efficiencies. This means that extremely inefficient catches (represented by the maximum efficiencies, i.e. by the highest amount the catch must be multiplied by to be optimal) are to a high degree caused by exogenous factors.

This is further reflected in the average values, which are higher and have higher fluctuations for the raw efficiencies when compared with the skipper skill efficiencies. This is illustrated in figure 10, where it is seen that while the average raw efficiencies fluctuate quite much during the year, especially for trawlers between 15 and 18 meters and 18 and 24 meters, the average skipper skill efficiencies are almost at level during the year without any fluctuations. Moreover the figure shows that while the average raw efficiencies differ some what between the three segments, the skipper skill efficiencies are almost equal for the tree segments.

The Standard Deviations and Medians of the two average efficiency measures show the same pattern as the averages and maxima, i.e. that the variation gets less for the skipper skill than for the raw efficiencies.

These results together indicate, that it is exogenous factors outside the control of the skipper that create large fluctuations in raw efficiency scores, and that it is to a high degree exogenous factors that cause high inefficiency, i.e. that inefficient catches are mostly caused by exogenous factors and only to a negligible degree by skipper skill.

Table 13. Basic statistics for raw and skipper skill efficiencies for Danish Trawlers between 12 and 15 m in 2002.

		Max	Mean	St.Dev	Median
Jan	Raw Eff.	6.85	1.63	0.89	1.32
	Skipper Skill Eff.	3.05	1.37	0.44	1.27
Feb	Raw Eff.	11.55	1.93	1.54	1.48
	Skipper Skill Eff.	3.19	1.41	0.49	1.23
Mar	Raw Eff.	5.51	1.60	0.79	1.32
	Skipper Skill Eff.	3.09	1.31	0.36	1.20
Apr	Raw Eff.	5.63	1.43	0.66	1.19
	Skipper Skill Eff.	3.24	1.30	0.41	1.14
May	Raw Eff.	4.63	1.52	0.70	1.24
	Skipper Skill Eff.	2.73	1.27	0.33	1.16
Jun	Raw Eff.	4.13	1.61	0.75	1.32
	Skipper Skill Eff.	2.79	1.32	0.38	1.22
Jul	Raw Eff.	8.97	1.57	1.04	1.28
	Skipper Skill Eff.	3.52	1.25	0.38	1.09
Aug	Raw Eff.	4.02	1.45	0.56	1.25
	Skipper Skill Eff.	2.38	1.29	0.35	1.17
Sep	Raw Eff.	9.18	1.53	1.01	1.18
	Skipper Skill Eff.	3.33	1.31	0.43	1.14
Okt	Raw Eff.	9.96	1.60	1.05	1.32
	Skipper Skill Eff.	3.22	1.33	0.42	1.25
Nov	Raw Eff.	6.85	1.55	0.87	1.19
	Skipper Skill Eff.	3.45	1.32	0.47	1.13
Dec	Raw Eff.	5.43	1.53	0.79	1.27
	Skipper Skill Eff.	3.32	1.28	0.38	1.17

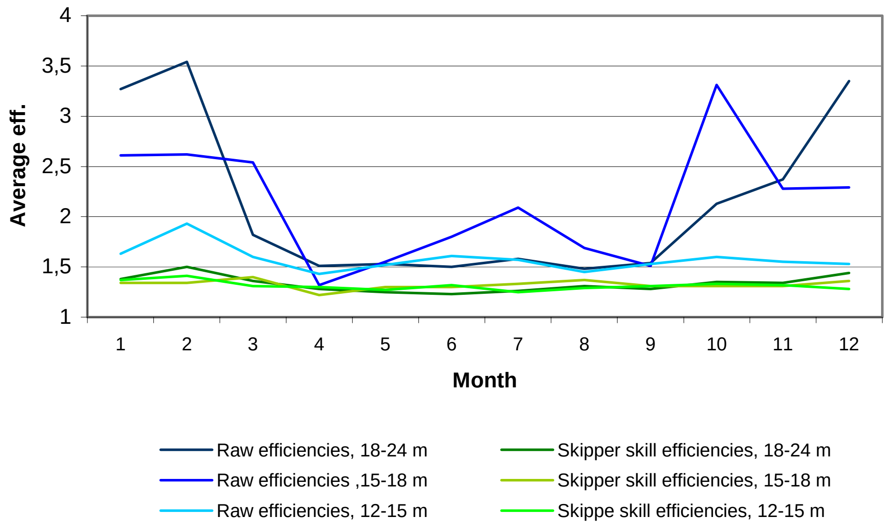
Table 14. Basic statistics for raw and skipper skill efficiencies for Danish Trawlers between 15 and 18 m in 2002.

		Max	Mean	St.Dev	Median
Jan	Raw Eff.	99.18	2.61	10.04	1.22
	Skipper Skill Eff.	4.02	1.34	0.56	1.15
Feb	Raw Eff.	81.19	2.62	7.99	1.27
	Skipper Skill Eff.	4.02	1.34	0.56	1.15
Mar	Raw Eff.	100.33	2.54	9.57	1.34
	Skipper Skill Eff.	3.28	1.40	0.45	1.26
Apr	Raw Eff.	5.75	1.32	0.60	1.10
	Skipper Skill Eff.	2.67	1.22	0.35	1.07
May	Raw Eff.	8.06	1.55	0.94	1.24
	Skipper Skill Eff.	3.30	1.30	0.42	1.16
Jun	Raw Eff.	31.24	1.80	3.14	1.21
	Skipper Skill Eff.	4.51	1.30	0.51	1.09
Jul	Raw Eff.	51.16	2.09	5.35	1.16
	Skipper Skill Eff.	5.77	1.33	0.65	1.07
Aug	Raw Eff.	7.57	1.69	1.01	1.48
	Skipper Skill Eff.	3.04	1.37	0.41	1.29
Sep	Raw Eff.	12.92	1.51	1.30	1.29
	Skipper Skill Eff.	5.05	1.31	0.49	1.20
Okt	Raw Eff.	170.36	3.31	16.28	1.50
	Skipper Skill Eff.	5.05	1.31	0.49	1.20
Nov	Raw Eff.	89.71	2.28	8.50	1.19
	Skipper Skill Eff.	4.24	1.31	0.55	1.11
Dec	Raw Eff.	50.89	2.29	5.02	1.35
	Skipper Skill Eff.	3.06	1.36	0.47	1.21

Table 15. Basic statistics for raw and skipper skill efficiencies for Danish Trawlers between 18 and 24 m in 2002.

		Max	Mean	St.Dev	Median
Jan	Raw Eff.	82.72	3.27	11.40	1.50
	Skipper Skill Eff.	4.96	1.38	0.54	1.27
Feb	Raw Eff.	105.16	3.54	10.98	1.58
	Skipper Skill Eff.	4.98	1.50	0.70	1.28
Mar	Raw Eff.	15.02	1.82	1.84	1.23
	Skipper Skill Eff.	4.75	1.36	0.57	1.11
Apr	Raw Eff.	6.36	1.51	0.84	1.18
	Skipper Skill Eff.	2.52	1.28	0.34	1.14
May	Raw Eff.	4.14	1.53	0.65	1.29
	Skipper Skill Eff.	2.36	1.25	0.29	1.15
Jun	Raw Eff.	6.15	1.50	0.80	1.18
	Skipper Skill Eff.	2.61	1.23	0.33	1.10
Jul	Raw Eff.	17.91	1.58	1.80	1.23
	Skipper Skill Eff.	4.05	1.26	0.39	1.15
Aug	Raw Eff.	6.46	1.48	0.69	1.33
	Skipper Skill Eff.	3.09	1.31	0.36	1.22
Sep	Raw Eff.	7.77	1.54	1.06	1.19
	Skipper Skill Eff.	4.70	1.28	0.47	1.11
Okt	Raw Eff.	51.01	2.13	5.13	1.26
	Skipper Skill Eff.	5.26	1.35	0.63	1.15
Nov	Raw Eff.	36.52	2.37	4.92	1.14
	Skipper Skill Eff.	4.60	1.34	0.64	1.05
Dec	Raw Eff.	75.40	3.35	9.55	1.19
	Skipper Skill Eff.	6.35	1.44	0.81	1.11

Figure 10. **Average raw and skipper skill efficiencies in each month of 2002, for each of the three trawl segments between 12 and 24 m.**



12. Discussion

The aim of the report has been (i) to investigate how fleet efficiencies are influenced by external factors set by management and (ii) to estimate skipper skill efficiencies for the tree major trawler segments of the Danish fleet.

In connection with (i) fleet efficiencies have been evaluated, using Data Envelopment Analysis (DEA), in each month of 2002 for 17 out of the 26 segments constituting the Danish fleet in 2002. For the remaining segments it has not been possible to perform DEA due to too few observations. Output orientated DEA has been employed, as the final aim has been to assess how output (catches) is influenced by exogenous management factors, and to build a module that evaluates catches as a function of management factors. Next DEA second stage tobit regressions have been performed for each of the 17 segments in each month of 2002, where the vessel efficiencies have been regressed against a number of relevant exogenous management variables, such as fishing time in different fishing areas, gross tonnage etc. The resulting second stage tobit models have been used to build a CPUE-generating module in *Mathematica*, with which it is possible (a) to estimate average efficiencies at segment and month level as a function of the chosen exogenous management variables, and (b) to generate new CPUE matrices as a function of the exogenous management variables. The new CPUE matrices can be used directly as input in the EMMFID model, and it is thus possible to assess the consequences of different management initiatives for the Danish fleet.

To assess skipper skill efficiencies a four-stage model, including evaluation of non-radial slacks has been used. It has been shown that for the three major trawl segments of the Danish fishing fleet in 2002, exogenous factors outside the control of the skipper are the major reason for high inefficiencies. Hence extremely low catches for a given trawl vessel is generally caused by external factors rather than by the skippers' skill. The success of the Danish trawl fishery therefore seems to be highly influenced by factors outside the control of the fishermen.

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Appendix A: On evaluation of average efficiencies

In the evaluations of average CPUE changes described above, the arithmetic average of the original DEA efficiencies has been used:

$$\theta_0^{av} = \frac{1}{N}\sum_{i=1}^{N}\theta_{0,i} \tag{A1}$$

Where N is the number of observations and $\theta_{0,i}$ the original DEA efficiency scores (before change of exogenous variables) of the individual vessels in the given segment and month. This average is used to determine the frontier CPUE values, which are evaluated by multiplying θ_0^{av} for a given segment and month by the average CPUE levels for that segment and month.

It must, however, be noted that by using arithmetic averages of efficiency as well as of CPUE levels, the resulting frontier CPUE values may exceed the maximum observed CPUE levels. It can be shown that if the output CPUE vector used in the DEA evaluations is one-dimensional, i.e. only contains one species group, the product of the average efficiency given by equation (A1) and the average CPUE level of the species group will always exceed the maximum observed CPUE level. This is, however, not always the case when the dimension of the CPUE vector is strictly greater than one, which is always the case in the present context, where 2 or more output CPUE groups have been used in each DEA program.

To avoid this error a weighted average efficiency measure for each output CPUE group could be used instead. This is given by:

$$\theta_k^{av} = \frac{\sum_{i=1}^{N}\theta_i \cdot CPUE_{k,i}}{\sum_{i=1}^{N} CPUE_{k,i}} \tag{A2}$$

Where $CPUE_{k,i}$ is the observed CPUE value in the k'th output group for the i'th observation in the given segment and month. Thus in this case the frontier values are evaluated by multiplying the CPUE values for a given species with the weighted efficiency score for the aggregated output group to which this species belongs. This approach will reduce the possible error connected with using the arithmetic average given in equation (A1), but will not necessarily remove this error completely. The reason is that the weighted efficiency scores given by equation (A2) can only be evaluated for the aggregated species groups used in DEA, while they are multiplied with the CPUE values disaggregated down to the single species levels used in the EMMFID model.

It has in the present context been tested how often the product of the arithmetic average (A1) of the efficiency and the average CPUE values for the aggregated DEA species groups will exceed the maximum observed CPUE values of the aggregated species groups. This will only happen in approximately 0.2% of the cases, and it has therefore been chosen to use the arithmetic average instead of the weighted average of the efficiency, as this simplifies the evaluations, and as it is believed that the error involved with using the arithmetic average (A1) is small.

Appendix B. Tobit regression parameters

Table 1B to 17B presents the tobit regression parameters resulting from the second stage DEA analyses for the 17 fleet segments from 2002 for which it has been possible to perform DEA. The following notation is used in all tables: ´OWNER´=Owner Status, ‘DAS3AN’=Fraction of time spent in Skagerrak, ‘DAS3AS’=Fraction of time spent in Kattegat, ‘DAS3BCD’=Fraction of time spent in the sound, Belt Sea and Baltic, ‘BTBRT’=Gross Tonnage, ‘INS’=Insurance value and ‘SIGMA’=variance of tobit residuals.

Table 1B. **Tobit Regressions coefficients for Liners and Gill Netters below 12 m in 2002.**

Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
2.7232	0.0063	-0.0296	0.8824	0.4091	0.2645	-0.0057	0.0008	2.3228	1
0.5685	0.0271	0.9137	0.9900	0.3584	-1.5876	0.2305	0.0214	3.7183	2
1.5593	0.0254	-0.2591	1.3575	1.8843	1.7935	0.2882	-0.0933	3.9327	3
3.8808	0.0148	-1.5475	0.3778	-0.4128	0.0039	0.1345	-0.1302	2.1386	4
2.0412	0.0201	-1.1099	0.6013	0.8741	0.2570	0.0152	0.0024	1.4813	5
2.4943	0.0205	-0.3486	0.9839	0.2994	-0.5464	-0.0100	-0.0370	2.4197	6
0.6964	0.0479	-0.0179	0.4305	1.0553	0.1121	-0.1226	0.1739	2.5520	7
2.7586	0.0340	-0.1287	-0.4119	0.3918	0.0509	-0.0511	-0.0822	2.4973	8
3.2023	-0.0044	-0.8667	-0.5321	-0.8086	-1.1019	0.0391	0.0901	2.4885	9
-0.6883	0.0005	-0.8212	1.0401	0.8247	1.4631	0.0735	0.2018	2.2660	10
2.8827	-0.0404	-1.1142	0.0197	-1.2419	-0.0508	0.1356	0.0520	2.0928	11
4.5515	-0.0058	-2.5276	1.2840	-1.0929	0.0097	0.0309	0.0197	2.1264	12

Table 2B. **Tobit Regressions coefficients for Danish Seiners/Netters/Trawlers below 12 m in 2002.**

Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
-0.7553	0.0339	0.4222	0.4048	-1.3953	-0.4551	0.0841	0.0166	1.2693	1
-0.6409	0.0574	0.2357	-1.6778	0.3119	-0.2548	-0.0609	0.1124	1.2106	2
-5.2850	-0.0148	4.4602	2.2691	0.8408	-0.5950	0.4727	-0.2340	1.8454	3
-1.9657	0.0419	1.1565	-0.1838	-0.8304	-1.1728	0.1885	-0.0497	1.3654	4
-2.2099	0.0097	2.8040	-0.6804	-2.8951	-0.2439	0.0798	-0.0526	0.2773	5
-0.3776	0.0215	0.6104	-0.8505	-0.0476	0.4005	-0.0190	0.0406	0.5368	6
1.2444	0.0115	0.3246	-5.2866	-0.5508	-0.3868	-0.0359	0.0031	0.6393	7
-4.4887	0.0482	3.6244	-1.1842	0.7325	0.2182	0.0195	0.0339	0.6642	8
-3.0076	0.0236	5.5140	-7.0254	-0.9734	-0.8627	-0.0938	0.0154	0.7861	9
-4.5415	-0.0215	6.6333	-8.6815	1.4126	0.6594	-0.0701	-0.0265	1.1893	10
0.1672	-0.0134	1.5902	-0.5419	-0.2487	-1.3100	0.1937	-0.1412	0.6176	11
-13.2834	0.0097	4.3583	10.1655	8.9526	8.6448	0.1041	-0.0272	0.5456	12

Table 3B. Tobit Regressions coefficients for Trawlers below 12 m in 2002.									
Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
-5.5467	-0.0301	6.2027	6.2359	7.9677	6.0451	-0.1765	-0.2456	0.7793	1
1.4334	-0.0348	-5.6940	8.1647	9.3909	7.5944	0.0441	-0.2324	1.1988	2
-9.0382	0.0298	4.6816	3.0704	3.7522	3.8790	0.0431	-0.0438	1.0162	3
-2412.1380	-0.0026	0.0219	2412.1623	2413.3692	2412.7535	0.0479	-0.0014	0.5802	4
4.7545	-0.0058	-3.6387	4.6086	5.2832	5.0445	-0.1983	-0.1736	0.4473	5
-9.4045	0.1418	0.9925	-5.1068	-4.6350	-3.7215	0.3414	0.4561	3.5164	6
-1.0237	0.0068	-0.0505	3.1646	3.5619	3.0134	-0.0029	-0.1248	0.6005	7
-11.3052	-0.0558	-0.0067	23.5582	21.3870	19.7869	-0.1109	-0.2941	3.0074	8
0.0826	-0.0018	0.3262	3.5594	3.9440	2.8876	-0.0590	-0.1516	0.8908	9
-0.9972	-0.0166	1.9363	1.5027	1.5733	0.2679	0.0072	0.0467	0.6243	10
0.9944	-0.0150	-0.3750	1.2894	2.3981	1.6636	0.2056	-0.3966	1.0522	11
-320.1173	0.0083	0.2471	321.5763	320.9911	319.6377	0.0838	-0.0606	0.9495	12

Table 4B. Tobit Regressions coefficients for Liners and Gill Netters, 12-15 m, in 2002.									
Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
1.6791	0.0025	0.2034	-0.4269	-0.1680	-1.2569	-0.0024	-0.0098	1.5358	1
0.2981	-0.0146	1.2932	-0.4744	0.3994	-1.0299	0.0637	-0.0115	2.2520	2
0.9283	0.0072	-0.5380	-0.3005	-0.7913	-0.2355	0.0592	0.0027	1.0917	3
1.7867	-0.0050	-0.2456	-0.3307	0.1806	-0.4076	0.0066	-0.0019	0.7313	4
1.4461	0.0021	0.0994	-0.9970	0.8361	-0.5357	0.0118	-0.0096	1.1481	5
-0.2502	-0.0085	-0.2139	0.0816	-0.1528	0.2365	0.0852	0.0225	0.9750	6
2.8020	0.0133	-0.9086	-0.9540	1.8213	-0.1103	-0.0281	-0.0016	1.4892	7
-0.2846	-0.0215	-0.2363	-0.1918	0.5679	-0.4079	0.1260	0.0075	1.5502	8
1.3633	-0.0174	-0.9704	-1.1910	0.0137	-1.4098	0.1160	-0.0080	1.5133	9
1.2982	0.0126	0.0791	-1.4214	0.2620	-0.5670	-0.0091	-0.0082	0.7698	10
1.1645	0.0051	-0.3641	-1.1294	0.2128	-0.5543	0.0464	-0.0105	1.4642	11
1.1527	-0.0036	-0.1723	0.1076	0.1659	-0.2244	0.0365	-0.0112	1.1905	12

Table 5B. Tobit Regressions coefficients for Danish Seiners/Netters/Trawlers, 12-15 m, in 2002									
Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
-4.9001	0.0116	-0.4891	-17.3723	4.7680	5.2766	0.0195	0.0194	0.3606	1
-0.7300	0.0260	-0.4861	0.9572	0.4985	0.6614	0.0133	0.0179	0.1079	2
-5.0647	0.1154	-2.9358	-1.4373	-0.0943	-1.6571	0.3392	-0.1142	1.7443	3
-12.8104	0.0225	2.6506	1.1714	-37.5614	8.5115	0.0639	0.0342	0.5933	4
-0.9369	0.0263	-1.5034	-1.5078	0.1611	0.0115	0.0580	0.1084	0.5697	5
1.6785	-0.0482	-1.7259	-16.9767	-23.7607	-0.0071	0.1634	-0.0482	0.4368	6
0.8000	-0.0185	-0.4397	-0.8339	0.0569	0.1185	0.0967	-0.0416	0.5522	7
-0.9967	0.0300	0.0043	-1.0076	-0.2793	-0.0424	0.0388	0.0189	0.5731	8
3.9592	-0.0157	-2.0602	-3.4443	-2.0966	0.0186	-0.0008	-0.0788	0.2980	9
-3.9914	0.0071	0.1070	0.0840	1.7281	0.0546	0.1724	0.0168	0.7379	10
0.2871	-0.0026	-0.2732	1.0003	0.8722	1.0673	-0.0247	0.0268	0.4317	11
-3.4730	-0.0163	-0.8592	-5.7878	-2.2750	-2.9148	0.3366	0.0897	0.0000	12

Table 6B. Tobit Regressions coefficients for Danish Seiners, 12-15 m, in 2002.

Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MON-TH
1039.1820	-0.0680	0.2138	-1036.5180	-1037.2129	-1036.9862	0.1630	-0.1662	0.4502	1
-0.0527	0.0309	1.3747	-0.8375	0.0939	-2.2947	0.0301	-0.0387	0.6981	2
-5554.5604	0.0556	6.1382	5546.9643	5548.6476	5548.4005	-0.1699	0.2856	0.6818	3
937.0447	0.0075	0.1255	-936.1408	-935.8658	-936.3894	0.0445	-0.1072	0.1866	4
-565.4630	-0.0040	0.1548	564.5025	564.5731	564.4833	0.1290	-0.0541	0.2536	5
6420.2968	0.2323	8.5759	-6443.7496	-6442.8122	0.0000	0.2537	0.0945	0.0000	6
-7.9642	0.0656	0.9596	4.6459	7.1654	6.6917	-0.0706	0.1141	0.9205	7
-0.7806	0.0117	0.0995	1.3114	1.4976	-0.0670	-0.0111	0.0131	0.1752	8
1153.5608	0.0140	-1.3503	-1154.0256	-1154.3298	-1151.9926	0.1599	-0.1421	0.5918	9
-23.7759	0.1510	6.8753	10.4164	9.2733	9.1222	0.0975	0.1080	1.7330	10
-27.7550	0.0060	0.0224	27.4173	28.0599	27.0446	0.1037	-0.0593	0.3386	11
62.3216	0.0173	-64.6868	-64.9350	0.3556	-0.8862	0.2189	-0.1028	0.9701	12

Table 7B. Tobit Regressions coefficients for Trawlers, 12-15 m, in 2002.

Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
1.6330	-0.0067	-0.2458	0.2326	-0.3336	-0.0590	0.0145	-0.0061	1.0584	1
0.1763	0.0052	-0.5890	0.1589	0.4266	-0.2716	0.0607	0.0198	1.0117	2
0.9489	-0.0075	-0.1073	-0.0781	0.8148	0.5229	0.0365	-0.0244	0.8795	3
0.5869	0.0001	0.0602	0.3517	0.1210	0.3555	0.0108	0.0035	0.8054	4
2.5119	-0.0161	-0.7274	-0.0519	0.1966	0.0650	0.0242	-0.0297	0.7674	5
0.9957	-0.0114	-0.1634	0.0159	0.5472	0.3829	0.0353	-0.0182	0.7513	6
1.2063	-0.0098	-0.1941	-0.0134	0.3872	0.3211	0.0451	-0.0386	0.7289	7
1.0202	0.0000	-0.2608	0.2746	0.0026	-0.1125	0.0218	-0.0034	0.5769	8
1.7344	-0.0043	0.1528	-0.4811	-0.3926	-0.5607	0.0088	-0.0157	0.7571	9
1.0455	-0.0054	-0.1899	0.1432	0.5449	0.6324	0.0074	0.0001	0.7389	10
0.5149	-0.0033	0.0542	0.1022	0.6159	0.3493	0.0157	0.0042	0.8937	11
-0.2106	0.0036	-0.3114	0.3770	0.7737	0.4596	0.0419	0.0139	0.6817	12

Table 8B. Tobit Regressions coefficients for Liners and Gill Netters, 15-18 m, in 2002.

Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
-1.0520	0.0488	-0.3003	0.1214	-4.4462	-0.6250	0.0015	0.0405	0.5676	1
0.9038	0.0256	0.0721	-0.5853	0.0000	-0.4588	0.0216	-0.0441	0.8549	2
0.4135	0.0093	-0.1110	0.5366	0.0000	-0.2338	-0.0035	0.0229	0.7994	3
0.3896	0.0286	-0.2609	-186.6923	0.0000	-1.9084	0.0035	-0.0010	0.4370	4
0.6614	0.0153	-0.1932	-3.6366	-4.0920	0.0000	-0.0021	-0.0002	0.2094	5
1.1596	0.0068	0.5236	-1.2962	0.0000	0.0000	0.0131	-0.0523	0.7012	6
0.3076	0.0028	-0.4849	-1.2456	-5.4268	0.0000	0.0064	0.0203	1.0314	7
1.2070	-0.0159	0.1579	-0.5971	-3.4770	0.0000	0.0095	-0.0053	0.6275	8
1.3820	0.0068	-0.2613	-0.1905	-31.5623	0.0000	-0.0113	0.0119	0.5947	9
1.1391	0.0051	-0.1787	-0.9289	-0.6359	-0.5659	0.0022	0.0067	0.3756	10
0.6768	0.0135	-0.1167	-8.5542	-5.7364	-0.3798	0.0004	0.0076	0.3879	11
-0.8287	0.0456	-0.4768	0.0000	0.0000	-0.9334	0.0077	0.0517	0.8600	12

Table 9B. Tobit Regressions coefficients for Danish Seiners, 15-18 m, in 2002

Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
8.4981	0.0117	-0.2569	-9.6277	-11.3277	-9.0289	-0.0209	0.1326	0.4803	1
-0.8602	-0.0951	-2.3225	-2.9161	1.3975	0.7477	0.1376	0.1399	0.8413	2
1.3355	-0.0236	0.1697	-1.3571	-0.0103	0.4572	-0.0044	0.1325	1.2103	3
0.1219	0.0004	-0.1909	-0.1090	6.5723	0.0000	0.0149	0.0389	0.4474	4
-0.4354	0.0144	-0.9802	-0.5674	-2.3402	-3.6389	0.0418	0.0592	0.3515	5
0.2970	0.0028	-0.7756	-1.1696	-153.8962	-4.5162	0.0459	0.0435	0.8523	6
3.8215	-0.0448	-0.5410	-1.6297	-1.9831	-0.7005	0.0342	-0.0042	0.8222	7
1.6722	0.0038	0.9810	-1.5947	-49.1209	-7.1725	-0.0313	0.0231	0.8955	8
-3.5544	0.0030	4.0096	-0.1263	-1.7947	-10.4785	-0.0028	0.0435	0.5773	9
-3.8386	-0.0075	6.2683	-2.6602	-2.9450	-2.1060	-0.0158	0.0335	1.2306	10
-0.6159	0.0121	-1.5128	-3.1689	-1.5916	-2.3372	0.0476	0.1421	1.1068	11
1.8520	0.0306	-4.0144	1.8877	3.4459	0.6986	-0.0283	0.1129	0.6667	12

Table 10B. Tobit Regressions coefficients for Trawlers, 15-18 m, in 2002.

Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
-2.7266	0.0283	0.1930	1.7849	2.4135	1.5201	-0.0048	0.0446	1.5764	1
0.0980	0.0015	0.3717	0.2392	0.7943	0.5561	0.0104	0.0020	1.0472	2
0.5306	0.0041	-0.2148	0.5635	1.3174	0.8430	-0.0050	0.0124	0.9376	3
0.8636	0.0017	-0.1900	0.2985	0.4825	0.2029	0.0026	-0.0015	0.5663	4
0.4491	0.0075	0.1073	-0.0428	0.8009	-0.3307	0.0001	0.0151	0.7665	5
-0.2169	0.0202	0.0126	-0.1872	0.3521	0.1343	-0.0026	0.0298	0.8248	6
0.0979	0.0116	0.2446	0.1482	0.5498	0.3771	-0.0069	0.0166	0.6529	7
1.1160	0.0067	0.0762	-0.3367	-0.4104	-0.4542	0.0053	0.0039	0.6179	8
0.7971	-0.0033	0.1477	0.3372	0.5887	0.1160	-0.0046	0.0051	0.5021	9
0.6222	0.0052	0.1354	0.7934	1.1347	0.6207	-0.0033	-0.0030	0.8777	10
0.2242	0.0115	0.1346	-0.0034	0.3508	-0.4281	-0.0028	0.0199	1.0953	11
-0.4729	0.0559	0.2063	-1.9235	-2.3062	-1.7353	-0.0081	0.0758	1.7944	12

Table 11B. Tobit Regressions coefficients for Liners and Gill Netters, 18-24 m, in 2002.

Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
1.7932	-0.0083	-0.4012	-1.6772	0.0000	0.0000	-0.0046	0.0026	0.2362	1
2.4682	-0.0225	-0.5883	-656.6728	0.0000	0.0000	0.0102	-0.0319	0.4431	2
2.1982	-0.0228	-0.2999	-701.9258	0.0000	-16.6659	0.0075	-0.0250	0.4371	3
0.7958	0.0052	-0.0272	-28.9684	0.0000	0.0000	-0.0016	0.0044	0.2073	4
1.0188	-0.0040	0.3649	-1.9242	-1.9985	0.0000	-0.0022	-0.0039	0.3049	5
1.1109	-0.0059	-0.0046	-1488.8934	-1.0399	0.0000	-0.0020	-0.0004	0.1854	6
1.5788	-0.0180	-0.0892	-174.1806	-2.4044	0.0000	0.0049	-0.0126	0.3704	7
0.8362	0.0053	-0.0237	-0.3254	0.1388	0.0000	0.0008	-0.0003	0.2662	8
-1.5520	0.0603	-0.2305	-5.5966	-0.5365	0.0000	0.0058	0.0269	0.6432	9
4.2720	-0.0590	-0.2085	-2.9864	0.3501	-4.9705	-0.0057	-0.0282	0.5045	10
3.8007	-0.0302	-0.4723	0.0000	-73.9695	-5.2616	-0.0119	-0.0128	0.6297	11
2.7003	-0.0359	-0.2577	0.0000	0.0000	0.0000	-0.0007	-0.0125	0.5896	12

Table 12B. Tobit Regressions coefficients for Danish Seiners, 18-24 m, in 2002.

Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
0.9841	-0.0016	0.1792	-0.0504	-4.5322	-0.0616	-0.0024	0.0086	0.3178	1
3.4159	-0.0586	-0.2340	-1.3367	0.0000	0.7671	-0.0146	-0.0036	1.1828	2
2.7129	-0.0570	0.2671	-0.4743	0.0000	0.9078	-0.0076	0.0136	1.2698	3
2.4646	-0.0257	0.1674	0.4745	-0.2733	0.0000	-0.0115	-0.0117	0.6394	4
1.5429	0.0005	-0.2189	0.0297	-0.4694	0.0000	-0.0160	0.0140	0.3612	5
0.3858	0.0102	0.0090	-0.2121	-0.5564	0.0000	-0.0065	0.0207	0.2553	6
-0.0921	0.0180	0.0450	0.0078	-0.3020	0.0000	0.0053	0.0076	0.4952	7
1.2558	-0.0099	0.2282	-0.0893	-0.0763	0.0000	0.0022	-0.0053	0.2810	8
1.1808	-0.0040	-0.1609	-0.0704	0.1300	0.0000	-0.0006	0.0061	0.3796	9
-0.4527	0.0001	0.3230	-0.3043	0.6449	-0.2501	0.0244	-0.0111	0.7823	10
-0.9545	0.0312	0.4976	0.2997	-97.9871	0.4346	0.0093	-0.0057	0.5934	11
2.2890	-0.0497	0.4803	1.1602	-0.2810	0.9520	0.0183	-0.0436	1.1943	12

Table 13B. Tobit Regressions coefficients for Trawlers, 18-24 m, in 2002.

Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
0.4662	0.0010	-0.3312	1.1271	0.2488	0.8255	0.0152	-0.0149	0.8567	1
0.7923	0.0213	0.3287	0.1334	-0.5362	-0.4446	0.0204	-0.0287	3.6000	2
2.2386	-0.0187	0.0028	0.1565	0.6904	0.2280	0.0064	-0.0257	1.1182	3
2.0431	-0.0148	0.2343	-0.4495	-1.1865	-0.3881	0.0060	-0.0157	0.7357	4
1.8452	-0.0102	0.1022	-0.1207	0.0686	-1.1269	0.0011	-0.0068	0.6026	5
1.4797	-0.0067	0.1997	-0.0783	0.2477	-1.2720	0.0029	-0.0084	0.6626	6
1.9079	-0.0135	0.0554	-0.1658	0.3266	-3.6093	0.0005	-0.0078	0.5188	7
2.0760	-0.0081	0.0628	-0.1200	-0.1476	-3.6374	-0.0045	-0.0037	0.6467	8
1.7538	-0.0019	0.0297	-0.3856	0.0616	-0.8697	-0.0037	0.0001	0.5621	9
2.8053	-0.0317	-0.0660	-0.0811	0.2019	-0.0943	-0.0016	-0.0086	0.8601	10
1.0550	-0.0052	0.0883	0.0175	0.9167	0.1574	0.0048	-0.0052	0.7943	11
1.6150	-0.0422	0.2832	1.5313	-0.1653	0.7209	0.0044	-0.0101	1.5378	12

Table 14B. Tobit Regressions coefficients for Other Trawlers, 24-40 m, in 2002.

Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
0.9962	0.0242	0.0967	0.0549	-2.2083	-1.8812	0.0002	0.0010	1.3623	1
-1.0024	-0.0056	0.6674	-0.0756	-2.0956	-3.3826	0.0152	-0.0038	1.2585	2
1.0222	-0.0032	0.2453	-0.0415	-1.6313	-0.4632	0.0022	0.0000	0.6680	3
1.2169	0.0020	-0.0404	-0.1220	0.1562	-0.5925	0.0020	-0.0030	0.6197	4
1.8468	0.0032	0.0127	-0.4655	0.0000	0.0000	0.0002	-0.0045	0.7650	5
1.3558	0.0005	-0.0029	-0.3285	10.9907	0.0000	0.0037	-0.0068	0.8661	6
1.8931	-0.0039	-0.2103	-0.9495	-0.5405	0.0000	0.0059	-0.0089	1.0138	7
3.0174	-0.0020	-0.1780	-2.0604	-2.2319	0.0000	0.0040	-0.0090	1.7032	8
2.7709	0.0234	1.3107	-2.1943	-6.5316	0.0000	0.0018	-0.0125	2.9829	9
2.7183	0.0232	0.4562	-2.0291	-1.8430	-5.6096	0.0046	-0.0145	2.4812	10
2.0048	-0.0312	0.0566	0.2387	-11.5756	-0.5473	0.0090	-0.0120	1.4244	11
-0.2333	0.0288	-0.1117	-0.0190	-0.3325	-1.1522	0.0105	-0.0083	1.5193	12

Table 15B. Tobit Regressions coefficients for Industry Trawlers, 24-40 m, in 2002.

Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
-3.8062	0.0466	0.1108	6.9895	0.0000	1.8049	0.0204	-0.0127	1.6106	1
-1.7479	0.0054	-0.7382	-8.3464	0.0000	0.7985	0.0096	-0.0001	0.8406	2
0.1326	0.0307	-0.1257	0.5350	0.0000	1.2586	0.0033	-0.0046	0.5950	3
0.7389	0.0016	0.0194	-119.0982	0.0000	0.0000	0.0029	-0.0034	0.2390	4
0.5275	0.0019	0.0472	-5.3797	0.0000	0.0000	0.0030	-0.0022	0.1824	5
0.2677	-0.0049	0.0867	-2.2599	0.0000	0.0000	0.0054	-0.0040	0.3976	6
-2.9096	0.0615	0.3102	-2.3920	0.0000	0.0000	0.0093	0.0004	0.8644	7
-0.8842	0.0396	0.0825	-0.9426	0.0000	0.0000	0.0064	-0.0058	0.6916	8
1.1076	0.0030	-0.2021	-3.3125	0.0000	0.0000	0.0013	-0.0012	0.3389	9
0.6954	-0.0138	-0.1876	-0.3667	0.0000	0.0000	0.0051	-0.0038	0.4244	10
1.6615	-0.0129	-0.2085	-34.5823	0.0000	1.7635	0.0041	-0.0078	0.6964	11
7.0888	-0.0287	-0.6808	-284.2598	0.0000	0.5848	-0.0189	0.0104	2.3757	12

Table 16B. Tobit Regressions coefficients for Northern Prawn vessels in 2002.

Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
-0.0601	0.0262	-0.1426	0.0000	0.0000	-3.4129	-0.0011	0.0212	0.5354	1
1.2839	0.0050	0.0868	0.0000	0.0000	-1.9668	0.0069	-0.0131	0.3053	2
0.6949	0.0134	0.2010	0.0000	0.0000	-2.0859	0.0040	-0.0030	0.2243	3
1.2741	0.0006	0.0396	0.0000	0.0000	0.0000	0.0069	-0.0109	0.1932	4
1.0246	0.0044	0.2815	0.0000	0.0000	0.0000	0.0113	-0.0125	0.3319	5
0.5781	0.0168	-0.0025	0.0000	0.0000	0.0000	0.0121	-0.0033	0.4346	6
0.6601	0.0135	0.0085	0.0000	0.0000	0.0000	0.0120	-0.0063	0.3690	7
1.3162	-0.0001	0.3385	0.0000	0.0000	0.0000	0.0131	-0.0196	0.3027	8
0.7302	0.0106	0.2684	0.0000	0.0000	0.0000	0.0087	-0.0055	0.2925	9
0.3842	0.0157	0.3741	0.0000	0.0000	0.0000	0.0055	0.0004	0.2962	10
-0.0508	0.0258	0.2141	-77.6891	0.0000	0.0000	0.0165	0.0018	0.5227	11
-0.7265	0.0459	0.5429	0.0000	0.0000	0.0000	-0.0195	0.0365	0.6821	12

Tabel 17B. Tobit Regressions coefficients for Mussel vessels in 2002.

Intercept	AGE	OWNER	DAS3AN	DAS3AS	DAS3BCD	BTBRT	INS	SIGMA	MONTH
-0.1454	0.0255	-0.1543	0.0000	-10.8390	-0.4422	-0.0306	0.0700	1.3873	1
0.9786	0.0123	0.0172	0.0000	-1.4729	-0.7156	0.0025	0.0207	0.5168	2
1.9594	0.0005	-0.4691	0.0000	-7.2027	-1.7497	0.0307	0.0066	1.0141	3
0.9360	0.0090	0.1871	0.0000	0.0492	-1.3697	0.0428	-0.0001	0.9619	4
1.6632	0.0052	-0.1766	0.0000	-0.3673	-0.9328	0.0305	0.0034	1.2710	5
1.5935	0.0029	-0.1110	0.0000	-3.7393	-0.1144	-0.0003	-0.0100	0.5376	6
-727.5925	-1.0933	703.2504	0.0000	727.4688	509.4749	4.4822	1.6425	0.3222	7
3.2536	-0.0038	-0.5583	0.0000	-1.7412	-1.1393	-0.0210	0.0155	1.4783	9
2.4935	0.0140	-1.0393	0.0000	-0.3461	-1.7941	-0.0385	0.0636	1.7115	10
1.2162	0.0353	-0.9821	0.0000	0.5748	-3.0920	-0.0137	0.0614	1.8651	11
3.4835	0.0045	-0.9887	0.0000	4.6815	-2.3950	0.0002	-0.0133	2.3691	12